PENNSYLVANIA LAND RECYCLING PROGRAM SITE CLEANUP PLAN

ARG REFINERY
BRADFORD, PENNSYLVANIA

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1.0 INTRODUCTION

On behalf of Chemtura Corporation, Conestoga-Rovers & Associates (CRA) has prepared this Site Cleanup Plan (SCP) for the American Refining Group (ARG) Refinery facility (formerly owned by Crompton-Witco Corporation) in Bradford, Pennsylvania. The report has been prepared in response to the Consent Order and Agreement dated June 8, 2004, which has been executed between the Commonwealth of Pennsylvania Department of Environmental Protection (PADEP), Chemtura Corporation, and ARG.

The SCP has been prepared in accordance with the PADEP approval letter dated October 29, 2007 (received October 31, 2007) for the Site Characterization Report/Remedial Investigation Report/Risk Assessment Reports dated July 2007 (SCR/HHRA/ERA). A copy of the letter is provided in Appendix A.

The SCP contains the elements set forth in 25 Pa. Code §245.311 and 25 Pa. Code §250.410. The SCP provides a description of the Site, the extent of soil, sediment, surface water, and groundwater impact, and the selected remedial approach for each area to be remediated. The plans for monitoring remediation progress, effectiveness, and confirming that the remedial actions have been completed are also contained herein.

1.1 REPORT ORGANIZATION

This report has been organized as described below:

Section 1.0	Section 1.0 states the purpose of the Site Cleanup Plan;
Section 2.0	Section 2.0 presents a summary of Site Characterization, Human Health Risk Assessment and Ecological Risk Assessment Reports;
Section 3.0	Section 3.0 presents a summary of the implemented and planned remedial activities;
Section 4.0	Section 4.0 presents the predesign, design, and construction/implementation considerations for each remedial technology;
Section 5.0	Section 5.0 presents the post-closure monitoring and maintenance for the five areas to be covered in the Foster Brook Facility;
Section 6.0	Section 6.0 presents the monitoring to be performed prior to the start of and during demonstration of attainment of the appropriate standards;

Section 7.0 Section 7.0 presents the proposed schedule for predesig implementation/construction, and reporting activities.

Section 8.0 Section 8.0 identifies the reports and documentation to bc r during the predesign, design, and remedial action implementation/construction activities.

2.0 SUMMARY OF SCR/HHRA/ERA REPORTS

In accordance with 25 Pa. Code §245.311, this section of the SCP provides a summary of the SCR/HHRA/ERA reports.

2.1 SITE DESCRIPTION

The Site is an active refinery located in the City of Bradford and in Foster Township of McKean County, as shown in Figure 2.1. The refinery has been in operation since the 1890s, making it the oldest active refinery in the United States. The Site occupies approximately 131 acres along a 1.5 mile stretch of Tunungwant Creek.

The Site is divided into four major areas (see Figure 2.2) which are used to describe the facility throughout this report. These four areas are:

i) Main Refinery (MR);

ii) Crude Tank Farm (CTF);

iii) Foster Brook Facility (FBF); and

iv) Packaging Plant (PP).

The refinery operations consist of five processing units, approximately 375 feedstock and product above ground storage tanks (ASTs), a main office building, a refinery office building, research and control laboratories, warehouse buildings, and maintenance buildings. Products manufactured at the Site include various lubricating oils, specialty products, and gasoline. Currently the Site has a cumulative storage capacity of approximately 1,337,000 barrels and a crude oil throughput of 10,000 barrels per stream day (BPSD). The Site receives crude oil by truck, railroad, and pipeline from the Pennsylvania grade crude oil region.

2.2 SITE HISTORY AND OPERATIONS

Portions of the Site and surrounding area were used for oil exploration and production, even before the Site was first used as a refinery. Various sections of the Site have been owned and operated as a refinery since the late 1800s.

In 1997, Chemtura sold the refinery to ARG who still owns and operates the Site. In accordance with the sales agreement with ARG, Chemtura has retained the environmental liability for past refining activity impacts to soil and groundwater at the Site.

The Refinery refines crude oil and manufactures, packages, stores, and distributes petroleum products in both bulk and packaged forms. The distribution percentages of the products manufactured and distilled from the processed crude oil are as follows:

i) 20 percent gasolines;
ii) 30 percent naphtha distillate solvents and Kensols;
iii) 40 percent finished lubricating oils; and
iv) 10 percent waxes and heavy fuel oil.

The operations are typical of a refinery and include atmospheric distillation, fractionation, stripping, purification, hydrotreating, various dewaxing operations, maintenance, research and development, storage, packaging, loading, unloading, and distribution. Typical of refinery operations, numerous kettles, tanks, pumps, compressors, heat exchangers, and ASTs are used.

2.2.1 STORAGE AND USE OF CHEMICALS

The Refinery produces gasoline, fuel oil, solvent naphthas distillate solvents, lubricant base oils, waxes and resins, dust control agents, and a variety of other petroleum specialties including shock fluids, camping fuel, asphalt cut back solvents, well treating solvent, extract blends, and quench oils.

2.2.2 ENVIRONMENTAL PERMITS

Current environmental permits for the Site include the following: AST Registration, NPDES Wastewater Discharge Permit, Industrial Wastewater Discharge Permit, Stormwater Discharge Permits, and Air Quality Control permitting for multiple sources.

2.2.3 STORMWATER DRAINAGE

The Plant Site is serviced with a stormwater collection system which is designed to direct select stormwater flows to the Refinery process sewer/oil recovery system (API separator system). There are three API Separators in the Main Refinery. One is located in each of the MEK Unit, Crude Unit, and Dubbs Area of the Refinery. The API Separators pretreat the water to remove floating oil and grease. The API Separator effluent then goes to the onsite Waste Water Treatment Plant (WWTP) which includes an induced air flotation system, biological treatment, and continuous sand filtration prior to discharge to Tunungwant Creek. In addition to the API Separator system for the Main Refinery, there is an API Separator that collects stormwater from the south portion of the Foster Brook Facility and pretreats the water prior to flowing into the two equalization ponds and then discharging to Tunungwant Creek.

The stormwater collection system includes eight stormwater outfalls. One permitted stormwater outfall (002) receives stormwater and treated wastewater and seven permitted stormwater outfalls (004 through 010) receive stormwater only. All of the outfalls discharge into Tunungwant Creek. Tunungwant Creek has been subject to considerable hydraulic improvement projects; most notably the straightening, channelizing, and provision of flood control walls by the Army Corps of Engineers in 1954. The flood control walls are only present in the Main Refinery section of the Site and do not extend through the Crude Tank Farm and Foster Brook Facility. The straightening and channelization work extended through the entire Site. Any incidental stormwater flow not entering the drainage system remains on or in the immediate proximity of the Site where it evaporates or infiltrates the ground surface.

ARG conducts annual stormwater sampling and inspections for all permitted outfalls, per the Facility's NPDES permit No. 0002674 which became effective November 1, 1999.

2.3 INVESTIGATIVE ACTIVITIES

2.3.1 INTRODUCTION

The investigations that have been conducted at the Site are extensive and provide a very thorough understanding of the Site conditions and the impact of oil product releases over the years on the local environment.

The investigative activities that have been performed to date at the Site can be summarized as follows:

Main Refinery

	# Soil Samples	*# Boreholes/ Soil Sample Locations(1)*	*# Test Pits/ Holes*	*# Wells/ Piezometers*	*# Groundwater Samples*
Total	269±	130±	0	240±	279±

Crude Tank Farm

	# Soil Samples	*# Boreholes/ Soil Sample Locations(1)*	*# Test Pits/ Holes*	*# Wells/ Piezometers*	*# Groundwater Samples*
Total	83±	67±	15	44±	96±

Foster Brook Facility

	# Soil Samples	*# Boreholes/ Soil Sample Locations(1)*	*# Test Pits/ Holes*	*# Wells/ Piezometers*	*# Groundwater Samples*
Total	344±	363±	4	132±	194±

Packaging Plant

	# Soil Samples	*# Boreholes/ Soil Sample Locations(1)*	*# Test Pits/ Holes*	*# Wells/ Piezometers*	*# Groundwater Samples*
Total	11±	3±	0	10	24±

Tunungwant Creek and Tributaries

	# Surface Water Samples	*# Sediment Samples*	*# Macroinvertebrate Samples*
Total	75±	46±	36

(1) Does not include locations where well/piezometer installed.

2.4 ENVIRONMENTAL SETTING

The current use of the Site is industrial and is expected to remain industrial in the future. Current land uses adjacent to the Site are:

i) vegetated undeveloped land to the north; and

ii) industrial/commercial/residential properties to the east, south, and west.

The Site is located in the Tunungwant Creek Valley. Tunungwant Creek flows northward and is located east of the south portion of the Site, bisects the middle portion, and is west of the Foster Brook Facility. Four tributaries (Kendall Creek, Bolivar Run, Foster Brook, and an unnamed tributary in the CTF) flow into Tunungwant Creek in the vicinity of the Site.

The City of Bradford experiences a humid continental type climate, characterized by large annual and daily temperature changes. The annual average precipitation as measured at the Bradford Airport is approximately 47 inches.

Regional precipitation runoff data for McKean County suggests that average annual runoff is approximately 20 to 25 inches (USGS, 1997). Evapotranspiration for McKean County in the north-central portion of Pennsylvania, where elevations are higher and temperatures are lower, is estimated to be approximately 15 inches. Therefore, annual regional groundwater recharge is estimated to be approximately 7 to 12 inches.

Within the City of Bradford, urban development including stormwater control, greatly reduces infiltration by increasing runoff. Similar storm water controls are present at the Site, including ditching and catchbasins that collect and direct storm water off Site, reducing local infiltration to the water table.

Potable water for the City of Bradford and Foster Township is provided by three man-made reservoirs located on the West Branch of Tunungwant Creek and the tributaries thereto. A City ordinance controls the use of groundwater for potable supply in the vicinity of the Site. However, unless the City notifies the property owner to connect to the City supply, such connection may not occur. There are no groundwater wells used as a community water supply source near the Site. There are also no Zone-2 wellhead protection areas within 1,000 feet of the Site.

2.5 HYDROGEOLOGIC SETTING

There are three separate aquifer units underlying the Site. Each is comprised of coarse-grained alluvial and is separated by clay aquitard units. These hydrogeologic units are, in descending order:

i) Upper aquifer: a water table (unconfined) aquifer comprised of the fill material, upper silty sand alluvial unit, and the upper alluvial unit, extending to the top of the upper clay unit;

ii) Upper clay aquitard: comprised of the upper clay unit and forming a lower boundary to the upper aquifer;

iii) Intermediate (second) aquifer: a confined aquifer comprised of the intermediate alluvial unit;

iv) Lower clay aquitard: comprised of the lower clay unit;

v) Lower (third) aquifer: a confined aquifer comprised of the lower alluvial unit; and

vi) Bedrock: comprised of the shale and sandstone bedrock and acting as a lower aquitard to the lower aquifer, and as lateral aquitards to the intermediate and upper aquifers. Small amounts of groundwater may discharge from the bedrock into the overburden aquifer units.

The hydrogeologic unit impacted by activities related to the Site is the Upper Aquifer, an unconfined aquifer generally on the order of 70 feet thick. This unit is underlain by the upper clay aquitard. Upward vertical gradients are present through the upper clay aquitard to the Upper Aquifer, thus preventing any possible impact upon the groundwater below the upper clay aquitard. Furthermore, the upward gradient tends to keep impacted groundwater near the water table surface.

Groundwater flow in the Upper Aquifer discharges to Tunungwant Creek and its tributaries.

i) upward gradient in the Upper Aquifer; and

ii) floating SPL.

results in only the upper 10-foot thickness of groundwater in the Upper Aquifer being impacted by constituents attributable to the Site.

2.5.1 GROUNDWATER LEVEL/SEPARATE PHASE LIQUID APPARENT THICKNESS MONITORING

During the Site Characterization Study, three groundwater and SPL thickness measurement events were performed, on all of the available wells at the Site. The measured groundwater levels were corrected to account for the SPL that floats atop the groundwater. These measurement events occurred in March/April 2003, April 2003, and December 2003 for the entire refinery. The apparent SPL thickness for December 2003 are provided on Figures 2.3a through 2.3c.

In addition to the groundwater monitoring events that were performed at the Site, a series of pumping tests were also performed. Three vertical well pumping tests and four horizontal well pumping tests were conducted in September 2003 to assess the effectiveness of vertical and horizontal wells on the containment and removal of SPL. The tests showed that:

i) Pumping in the area of an SPL plume causes a depression in the groundwater table which, in the area of an SPL plume, results in SPL flowing to the well and the accumulation of greater thicknesses of SPL within the depression. The greater SPL thickness results in more effective SPL removal.

ii) The overlapping influences of pumping all of the horizontal wells provides significantly more drawdown than the pumping of an individual well. This results in more effective prevention of SPL and associated impacted groundwater migration to Tunungwant Creek.

2.5.2 PIPELINE INVESTIGATIONS

As part of the Site Characterization Study, known abandoned underground pipelines were investigated to determine their integrity, identify pipeline contents (if any), inspect the adjacent and underlying soils for visual impact, and verify the adequacy of the pipeline abandonment methods used. The investigations showed that:

i) known abandoned underground pipelines, including the Duke Center crude oil pipeline, were structurally in good condition;

ii) known abandoned pipelines on the Site contained clean water. No indication of product was observed in the water samples;

iii) no indication of leakage from known pipelines was observed in the soils at the investigation locations; and

iv) the abandonment techniques were adequate to prevent future releases from known abandoned pipelines.

2.6 CHEMICAL SITE CHARACTERIZATION

In order to evaluate the chemical data collected during the Site Characterization Study, the data have been grouped into geographic areas at the Site that match the environmental Exposure Units (EUs) developed for the Site. Each of the environmental Exposure Units has its own unique characteristics and usage patterns which were taken into consideration in assessing the data.

As appropriate, all of the analytical data have been screened by comparing the measured concentrations to the applicable and appropriate guidance values established by PADEP for the various media. The analytical results for the groundwater and soil media were compared to the most stringent PADEP Chapter 25, Act 2 Statewide Health Standard (SHS) Medium Specific Concentrations (MSCs) for each chemical analyzed. The appropriate SHS MSC for groundwater was selected from PADEP Title 25, Chapter 250, Appendix A, Tables 1 and 2, based on the following:

i) the groundwater underlying the Site was determined to be used;
ii) the groundwater's total dissolved solids concentration is <2,500 mg/L; and
iii) the land use is Non-Residential (NR).

The appropriate SHS MSC for soil was selected from PADEP Title 25, Chapter 250, Appendix A, Tables 3 and 4, based on the following:

i) most stringent MSC for Direct Contact Numeric Values and Soil to Groundwater Numeric Values;
ii) the land use is Non-Residential (NR);
iii) the groundwater underlying the aquifer is used; and
iv) the groundwater's total dissolved solids concentration is <2,500 mg/L.

For soils, the results were segregated into 3 intervals:

i) surface soil (0 to 2 ft bgs);
ii) unsaturated soil (2 ft bgs to the seasonally high groundwater table or a maximum of 15 ft bgs, whichever occurred first); and
iii) saturated soil (from the seasonally high groundwater table to 15 ft bgs).

For saturated soils, the standard used was 1/10th of the generic value for the appropriate parameters.

The appropriate SHS MSC for surface water was selected based on the most stringent of the following:

i) residential groundwater SHS MSC; and
ii) Chapter 16, Table 1, Water Quality Criteria.

For sediment, residential direct contact Act 2 criteria were used.

All of the data collected during the Site Characterization Study were QA/QC validated prior to use and found to be acceptable for almost all uses. To the extent that QA/QC information was available, it was also possible to validate the majority of the historic data. In most cases, the historical data were deemed acceptable. For some of the older reports, the QA/QC information was not available and therefore, a meaningful validation of the data from these reports could not be made. In general, this SCR relies primarily upon the most recent data, all of which has been evaluated for QA/QC. Consequently, the conclusions drawn from the data are valid. The unvalidated historical data has simply been used where necessary to fill minor gaps in the recent data set or to provide an indication of expected trends.

2.6.1 CHEMICAL CHARACTERIZATION SUMMARY

For the discussions provided in the subsequent sections, the following descriptions are used:

i) low level exceedances are ≤5 times the SHS MSC;

ii) moderate exceedances are >5 to ≤50 times the SHS MSC; and

iii) significant exceedances are >50 times the SHS MSC.

Groundwater locations which had exceedances of different levels on different dates were assigned the higher level in the following discussion.

2.6.1.1 ENTIRE SITE

Significant iron and manganese exceedances occur throughout the groundwater underlying and upgradient of the Site. These conditions are believed to be typical for the area although the Site has caused some increase of the iron and manganese concentrations beneath the Site. There are no applicable SHS MSCs for iron or manganese in soil. In general, the concentrations of iron and manganese in groundwater are holding constant or slowly decreasing with time. These two parameters are not further discussed in the following sections.

2.6.1.2 MAIN REFINERY (EXPOSURE UNIT 1)

Media	*Number of Locations with Exceedances* [1] *Groundwater*	*Surface Soil*	*Unsaturated Soil*	*Saturated Soil*
Number of Sample Locations	21 to 87	10 to 12	84 to 98	93 to 112
Non-Chlorinated VOCs	7/10/4	1/0/0	9/1/0	11/3/0
Chlorinated VOCs	3/0/0	0/0/0	0/0/0	0/0/0
PAHs	7/4/4	0/0/0	5/0/0	6/1/0(3)
Arsenic	37/0/0(2)	0/0/0	0/0/0	13/0/0
Other Metals	3/4/2(2)	2/0/0(4)	3/0/0	27/3/0

(1) 7/4/4 = number of locations with low level/moderate/significant exceedances.
(2) Dissolved Metals
(3) Excluding naphthalene which is included in Non-Chlorinated VOCs.
(4) Background concentration for lead greater than on-Site exceedance.

Number of SPL Plumes : 16 (SPL-1 through SPL-15 and SPL-29)

Estimated Volume of SPL based on Corrected Thickness : 55,200 gallons

The above shows that much of the groundwater and saturated soil underlying the Main Refinery has been impacted by non-chlorinated VOCs, PAHs, and arsenic. The areas of greatest impact are those beneath or downgradient of SPL plumes. In general, the groundwater PAH concentrations are decreasing with time while the non-chlorinated VOCs are holding constant or decreasing with time.

2.6.1.3 ADMINISTRATION AND RESEARCH AREA (EXPOSURE UNIT 2)

Media	*Number of Locations with Exceedances* (1) *Groundwater*	*Surface Soil*	*Unsaturated Soil*	*Saturated Soil*
Number of Sample Locations	8 to 9	3	6	4 to 6
Non-Chlorinated VOCs	1/0/0	0/0/0	0/0/0	0/0/0
Chlorinated VOCs	1/3/2(2)(5)	0/0/0	0/0/0	0/0/0
PAHs	0/0/0	0/0/0	0/0/0	0/0/0
Arsenic	4/0/0(4)	0/0/0	0/0/0	0/0/0
Other Metals	1/0/0(3)(4)	0/0/0	0/0/0	1/0/0

(1) 1/3/2 = number of locations with low level/moderate/significant exceedances.
(2) Not sourced by activities attributable to the Site.
(3) Background concentration for aluminum greater than on-Site exceedance.
(4) Dissolved Metals.
(5) Background concentrations for Cis-1,2-DCE and VCM greater than on-Site exceedances.

Number of SPL Areas : 1, a continuation of SPL-14 from EU-1
Estimated Volume of SPL: Included in EU-1

The above shows that the Administration and Research area has been minimally impacted by Site-related activities except for the area adjacent to Kendall Avenue which correlates with the SPL in this area. The only environmental concern is associated with chlorinated VOC concentrations in the groundwater and this situation appears to be decreasing with time and is not related to Site activities.

2.6.1.4 CRUDE TANK FARM (EXPOSURE UNIT 3)

	Number Of Locations With Exceedances (1)			
Media	*Groundwater*	*Surface Soil*	*Unsaturated Soil*	*Saturated Soil*
Number of Sample Locations	13 to 36	17 to 20	33 to 34	11
Non-Chlorinated VOCs	2/0/1	0/1/0	2/0/0	1/0/0
Chlorinated VOCs	0/5/6 (2)(3)	0/0/0	0/0/0	0/0/0
PAHs	0/0/0	0/0/0	0/0/0	0/0/0
Arsenic	3/0/0 (4)	3/0/0	1/0/0	2/0/0
Other Metals	1/0/0 (4)	2/0/0	1/0/0	2/0/0

(1) 0/5/6= number of locations with low level/moderate/significant exceedances.

(2) Not sourced by activities attributable to the Site.

(3) Background concentration(s) greater than on-Site exceedances.

(4) Dissolved Metals.

Number of SPL Areas : 3 (SPL-16 to SPL-18)
Estimated Volume of SPL based on Corrected Thickness : 7,500 gallons

The above shows that the Crude Tank Farm has been minimally impacted by Site related activities except for the three areas where SPL is present. No trend with time could be discerned for the non-chlorinated and chlorinated VOC groundwater concentrations.

2.6.1.5 FOSTER BROOK FACILITY SOUTH (EXPOSURE UNIT 4)

Number Of Locations With Exceedances (1)

Media	*Groundwater On-Site*	*Groundwater Downgradient*	*Surface Soil*	*Unsaturated Soil*	*Saturated Soil*
Number of Sample Locations	63 to 78	4 to 11	34 to 38	67 to 115	22 to 52
Non-Chlorinated VOCs	8/7/27	1/2/2	3/4/0	4/11/20	6/5/9
Chlorinated VOCs	1/6/0	0/0/0	2/1/0	2/0/0	0/1/0
PAHs	2/3/0 (3)	1/0/0	1/0/0	0/3/0(3)	1/1/0(3)
Arsenic	32/1/0(2)	2/0/0 (2)	0/0/0	1/0/0	3/0/0
Other Metals	11/1/0 (2)	2/0/0 (2)	9/3/0	7/0/0	0/1/0

(1) 8/7/27 = number of locations with low level/moderate/significant exceedances.

(2) Dissolved Metals.

(3) Excluding naphthalene which is included in non-chlorinated VOCs.

Number of SPL Areas : 7 (SPL-22 to SPL-28)

Estimated Volume of SPL based on Corrected Thickness : 19,200 gallons

The above shows that much of the groundwater, unsaturated subsurface soil, and saturated soil underlying the Foster Brook Facility South has been significantly impacted by non-chlorinated VOCs. The groundwater also has low-level impacts due to PAHs and metals, primarily arsenic. The areas of greatest impact are the Light End Tank Farm, Garage/Shed Area, and the Former Burn Pit Area. These three areas correlate with areas where SPL is present. On-Site groundwater concentrations for the PAHs and non-chlorinated VOCs appear to be constant or decreasing with time.

2.6.1.6 FOSTER BROOK FACILITY NORTH (EXPOSURE UNIT 5)

	Number Of Locations With Exceedances (1)			
Media	*Groundwater*	*Surface Soil*	*Unsaturated Soil*	*Saturated Soil*
Number of Sample Locations	3 to 9	28	19 to 25	9 to 11
Non-Chlorinated VOCs	0/0/0	0/0/0	0/0/0	0/0/0
Chlorinated VOCs	2/1/0	0/0/0	0/0/0	0/0/0
PAHs	0/0/0	0/0/0	0/0/0	0/0/0
Arsenic	0/0/0 (2)	2/0/0	1/0/0	6/0/0
Other Metals	4/0/1 (2)	2/0/0	1/0/0	3/1/0

(1) 2/0/1 = number of locations with low level/moderate/significant exceedances.

(2) Dissolved Metals

Number of SPL Areas : None

The above shows that the Foster Brook Facility North has been minimally impacted by Site related activities.

2.6.1.7 PACKAGING PLANT (EXPOSURE UNIT 6)

Media	*Number Of Locations With Exceedances (1)*			
	Groundwater	*Surface Soil*	*Unsaturated Soil*	*Saturated Soil*
Number of Sample Locations	9	NS	3	NS
Non-Chlorinated VOCs	0/0/0		0/0/0	
Chlorinated VOCs	0/7/0		0/0/0	
PAHs	0/0/0		0/0/0	
Arsenic	0/0/0 (2)		0/0/0	
Other Metals	0/0/0 (2)		0/0/0	

(1) 0/7/0 = number of locations with low level/moderate/significant exceedances.

(2) Dissolved Metals

NS Not Sampled

Number of SPL Areas : 2 (SPL-20 and SPL-21)
Estimated Volume of SPL based on Corrected Thickness : 1,300 gallons

The above shows that the groundwater underlying the Packaging Plant has been moderately impacted by chlorinated VOCs. The area of impact correlates with the location of the two SPL plumes. No trend with time could be discerned for the chlorinated VOC groundwater concentrations.

2.6.1.8 TUNUNGWANT CREEK (EXPOSURE UNIT 7)

Number Of Locations With Exceedances (1)

Media	*Surface Water*		*Sediment*
	May 2005	*August 2006*	
Number of Sample Locations	46	29	30 to 38
Non-Chlorinated VOCs	0/0/0	0/0/0	0/0/0
Chlorinated VOCs	5/0/0	4/0/0	0/0/0
PAHs	0/8/0	0/7/0	0/0/0
Arsenic	0/0/0 (2)	0/0/0(2)	24/1/0
Other Metals(3)	7/0/0 (2)	1/0/0(2)	3/0/0

(1) 7/0/0 = number of locations with low level/moderate/significant exceedances.

(2) Dissolved Metals

(3) Not including iron and manganese

The above shows that Tunungwant Creek has been minimally impacted by Site-related activities. This is supported by the results of the macroinvertebrate study which showed that while a slight to moderate impairment is evident, no toxic impact attributable to Site related chemicals was apparent. The major factors causing the impairment are habitat modifications and continuing physical disturbances that have been performed in conjunction with flood control efforts.

2.6.1.9 NATIONAL TRANSIT PROPERTY (EXPOSURE UNIT 8)

Media	*Number Of Locations With Exceedances (1)* Groundwater	*Surface Soil*	*Unsaturated Soil*	*Saturated Soil*
Number of Sample Locations	3 to 53	42 to 52	44 to 47	16 to 35
Non-Chlorinated VOCs	5/28/6	4/1/0	3/0/0	6/0/0
Chlorinated VOCs	2/1/0	0/0/0	0/0/0	0/0/0
PAHs	3/0/0	0/0/0	0/0/0	0/0/0
Arsenic	0/0/0 (2)	0/0/0	0/0/0	0/0/0
Other Metals	1/0/0 (2)	0/0/0	0/0/0	0/0/0

(1) 6/2/0 = number of locations with low level/moderate/significant exceedances.

(2) Dissolved Metals

Number of SPL Areas	: 2 (part of SPL-18 and SPL-19)
Estimated Volume of SPL based on Corrected Thickness	: 450 gallons (on-Site)
	: 540 gallons (off-Site)

The above shows that the groundwater and saturated soil underlying the National Transit Property has been significantly and moderately impacted, respectively, by non-chlorinated VOCs. The areas of highest impact correlate with the areas where SPL is present in the eastern one-third of the Property.

2.6.2 SEPARATE PHASE LIQUID

Thirty SPL plumes with a total estimated volume of 85,200 gallons (corrected thickness) currently exist on-Site. The number of plumes and volume (corrected thickness) for each Exposure Unit are:

Exposure Unit	*SPL Plumes*	*Volume (Gallons)*
EU-1	SPL-1 through SPL-15 and SPL-29	55,200
EU-2	continuation of SPL-14	included in EU-1
EU-3	SPL-16 through SPL-18	8,500
EU-4	SPL-22 through SPL-28 and SPL-30	19,200
EU-5	0	0
EU-6	SPL-20 and SPL-21	1,350
EU-8 (on-Site)	SPL-18 and SPL-19	450
EU-8 (off-Site)	SPL-18	540

SPL Plume	*Location*	*Description*	*Specific Gravity*	*Dynamic Viscosity (centipoise)*
SPL-1	MEK Unit	Solvent Distillate	0.84 to 0.86	10.2
SPL-2	MEK Unit	--	0.82	--
SPL-3	MEK Unit	MN (Medium Neutral)	--	--
SPL-4	MEK Unit	--	--	--
SPL-5	ROSE Unit	HN (Heavy Neutral) with MN	0.82 to 0.87	21.6
SPL-6	ROSE Unit	HN	0.79	--
SPL-7	ROSE Unit	HN and MN	0.85 to 0.89	89.0
SPL-8	ROSE Unit	--	--	--
SPL-9	Dubbs Unit	--	--	--
SPL-10	Crude Unit/ Upper Yard	Solvent Distillate with LLN and HN	0.84 to 0.87	4.44
SPL-11	Crude Unit	Solvent Distillate with MN and HN	0.86	12.4
SPL-12	MR Barrel House	MN and HN	0.86	10.3
SPL-13	MR Barrel House	HN, MN and Solvent Distillates	0.83 to 0.88	46.3
SPL-14	MR Barrel House/Adm	HN and Solvent Distillates	0.84	
SPL-15	Erie Wye Unit	Unknown with Solvent Distillate	0.80 to 0.83	2.29
SPL-16	CTF	--	0.82	3.49
SPL-17	CTF	--	0.87	17.5
SPL-18	Independent Production Area South	2001 - Severely Weathered Crude 2003 – Light End Hydrocarbons	0.79 to 0.82	2.23
SPL-19	NT Property	--	--	--
SPL-20	Packaging Plant	--	0.88	91.1
SPL-21	Packaging Plant	--	--	--

SPL Plume	*Location*	*Description Gravity*	*Specific Gravity*	*Dynamic Viscosity (centipoise)*
SPL-22	Bulk Haul/	Gasoline or Diesel based (MW-TF10)	0.84 to 0.87	10.5
	Light End Tank Farm	Gasoline based (MW-TF28)	0.74 to 0.75	0.96
SPL-23	FB Barrel House	--	0.89	35.1
SPL-24	Light End Tank Farm	--	--	--
SPL-25	Former Impoundment Area	--	--	--
SPL-26	Garage/Shed Area	Gasoline Based	0.74 to 1.00	3.25
SPL-27	Bauxite Fill Area	Gasoline Based	0.85 to 1.00	11.3
SPL-28	Former Burn Pit Area	--	0.92	1,140
SPL-29	Platformer Unit	--	--	--
SPL-30	Railway Unloading, Foster Brook	Crude	--	--

In addition, 2 off-site SPL plumes upgradient of the Site have been identified. One is a newly identified SPL plume located on the Buffalo and Pittsburgh railway south of Bolivar Drive (i.e., SPL-31) and the other on the Custer City Oil property north of Bolivar Drive (i.e., SPL-CC01).

2.7 FATE AND TRANSPORT EVALUATION

An evaluation was conducted of the potential fate and transport of chemicals detected in the groundwater beneath the Site. The fate and transport evaluation showed that:

i) the organic chemicals detected in groundwater beneath the Site are primarily related to the SPL present on top of the water table;

ii) the most significant potential migration pathway for chemicals present in the groundwater is discharge to surface water;

iii) the leaching of chemical constituents from the SPL to groundwater is resulting in lower groundwater concentrations than would be calculated using partitioning theory;

iv) only the groundwater flowing through the upper 10 feet or less of the upper aquifer is impacted by Site-related chemicals and contributes chemical loading to the surface water;

v) the total chemical loading from groundwater discharge to surface water results in estimated in-stream concentrations that are below the screening criteria for all detected chemicals except for a few parameters with low level exceedances;

vi) the calculated chemical loadings from the groundwater to surface water are not a significant concern to human health or the ecological aquatic environment;

vii) the surface water analytical results converted to 7Q10 conditions are consistent with the results of the surface water concentrations calculated based on groundwater loading in that only a few parameters with low level exceedances were detected in a few locations sporadically within the Site reaches of Tunungwant Creek and, in the majority of the locations, the concentrations were similar to the upstream concentrations;

viii) the surface water analytical results show that the Site is not adversely impacting the four tributaries;

ix) the calculated chemical loadings from groundwater are conservative and are expected to decrease in the future as the SPL continues to be removed from the subsurface;

x) the mobile SPL in EU-1 is being controlled and its volume reduced by the interim remedial measures being implemented; and

xi) the SPL plumes in EU-3, EU-4, and EU-6 are relatively immobile and the interim remedial measures of source removal which are currently in place will prevent potential migration of these plumes to the surface water.

2.8 HUMAN HEALTH RISK ASSESSMENT

The risk characterization integrates the exposure assessment and toxicity assessment to provide a complete evaluation of the potential human health risks associated with exposure to Constituents of Potential Concern (COPCs) at or near the Site. Two levels of exposure were evaluated:

i) the Central Tendency (CT), which utilizes the mean COPC concentrations and approximates the most probable exposure conditions; and

ii) the Reasonable Maximum Exposure (RME), which utilizes the 95 percent upper confidence level of the COPC mean concentrations and approximates maximum exposure conditions.

The estimated cumulative carcinogenic risks resulting from exposure to Site COPCs were compared to a cumulative risk (TCR) of 10^{-4}. Estimated non-carcinogenic hazards were calculated and compared to a Hazard Index (HI) of 1. A summary of the Reasonable Maximum Exposure (RME) cumulative risk results is presented below:

Exposure Unit	*Construction Worker*		*Indoor Worker*		*Outdoor Worker*		*Trespasser*		*Recreational Visitor*		*Resident/Child/ Adults*	
	CR	*HI*	*CR*	*HI*	*CR*	*HI*	*CR*	*HI*	*CR*	*HI*	*CR*	*HI*
EU1	1.1E-04	21,000	7.4E-05	6.9	2.2E-06	0.09	2.3E-07	0.023	NA	NA	NA	NA
EU1 Off-Site Hilton Street	--	0.46	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EU1 Off-Site Penn Electric	--	0.07	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EU1 Off-Site Mill Street	7.4E-06	6,600	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EU1 Off-Site B&P Railroad (MEK & Rose)	1.5E-05	7,500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EU1 Off-Site Conrail	9.6E-07	6,600	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EU1 Off-Site B&P Railroad (Crude Unit)	5.2E-06	14,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EU1 Off-Site Kendall Avenue	2.7E-04	17,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EU1 Off-Site Werzalit	2.2E-06	17,000	2.1E-06	0.12	NA	NA	NA	NA	NA	NA	NA	NA
EU2	1.2E-05	21,000	2.7E-06	0.033	9.9E-07	0.016	1.2E-07	0.005	NA	NA	NA	NA
EU3	7.0E-04	22,000	7.8E-05	1.5	1.7E-05	0.24	2.1E-06	0.071	NA	NA	NA	NA
EU3/EU8 Off-Site B&P Railroad	2.3E-04	21,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EU3 Off-Site Conrail	4.0E-04	38,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EU4	9.7E-03	130,000	2.5E-03	150	1.4E-05	2.3	1.4E-06	0.24	NA	NA	NA	NA
EU4 Off-Site PennDOT	9.1E-04	14,000	NA	NA	NA	NA	5.1E-05	0.18	NA	NA	NA	NA
EU4 Off-Site Bolivar Drive	5.7E-07	1,100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EU4 Off-Site B&P Railroad	3.5E-04	12,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EU5	1.7E-06	10	7.6E-06	0.16	1.8E-05	0.39	2.2E-06	0.39	NA	NA	NA	NA
EU6	2.1E-06	1,000	1.9E-06	0.036	NA	NA	NA	NA	NA	NA	NA	NA
EU6 Off-Site Graham Packaging	1.3E-06	1,000	9.9E-07	0.006	NA	NA	NA	NA	NA	NA	NA	NA
EU7 (Child/Adult)	NA	NA	NA	NA	NA	NA	NA	NA	8.1E-05	0.71/0.12	NA	NA
EU8 Off-Site Residential	2.3E-06	18,000	3.5E-06	0.09	NA	NA	NA	NA	NA	NA	2.5E-05	2.2/0.68

Notes:

NA = Not Applicable

-- = not calculated

The results of the HHRA show that the risks exceeding the cumulative risk of 10^{-4}, were identified for:

i) the indoor worker in EU4;

ii) the on-Site construction worker in EU1, EU3, EU4, and

iii) the off-Site construction worker in EU1-Kendall Avenue, EU3/EU8-B&P Railroad, EU3-Conrail, EU4-PennDOT, and EU4-B&P Railroad.

EU Hazard Indices exceeding the target HI of 1 were identified for:

i) the indoor worker in EU1, EU3, and EU4;

ii) the on-Site construction worker in EU1, EU2, EU3, EU4 , EU5, and EU6; and

iii) the off-Site construction worker in EU1-Mill Street, EU1-B&P Railroad (MEK/Rose), EU1-Conrail, EU1-B&P Railroad (Crude Unit), EU1-Kendall Avenue, EU1-Werzalit, EU3/EU8-B&P Railroad, EU3-Conrail, EU4-PennDOT, EU4-Bolivar Drive, EU4-B&P Railroad, EU6-Graham Packaging, and EU8-Residential.

For the resident, the results show an HI exceeding 1 for a child in EU8-Residential.

It should be noted that these cancer risk and HI exceedances incorporate some highly conservative assumptions. It is improbable that the same person would experience all potential exposures associated with the Site, or that he/she would experience these exposures over the periods of years specified in the individual RME scenarios.

Site-specific standards (SSSs) were developed for each COPC exceeding Statewide Health Standards (SHS) in each media. Briefly, the SSSs were developed by conducting the RA process in reverse. In other words, the HQ/HI formula and risk formula are solved for the exposure concentration term by setting the HI or risk to a specified target level. SSSs were developed for a target HI of 1 and target risk of 1E-05. The SSSs for all receptors and exposure pathways is provided in the SCR. The SSSs will be used for demonstration of attainment purposes.

2.9 ECOLOGICAL RISK ASSESSMENT

2.9.1 SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT (STEPS 1 AND 2)

The Screening Level Ecological Risk Assessment that was performed for the Site included the following three components in support of the Assessment:

i) A Wetlands Delineation;

ii) A Habitat Characterization Study; and

iii) A Benthic Macroinvertebrate Study.

The conclusions formulated for each of these components of the Ecological Risk Assessment are as follows:

Wetlands Delineation

i) There are no "Exceptional Value" wetlands on the Site.

ii) All of the wetlands present on the Site are classified as "Other" wetlands on the basis of criteria identified in Pennsylvania Chapter 105.17.

iii) The types of wetlands and aquatic habitats encountered on the Site include:
- Riverine open water upper perennial;
- Riverine open water intermittent;
- Palustrine emergent wetland;
- Palustrine scrub-shrub wetland;
- Palustrine forested wetland; and
- Palustrine open water

Habitat Characterization Study

i) There are 10 general types of terrestrial habitats and cover types on the Site and in the surrounding area including:
- Developed
    - Industrial
    - Residential
    - Commercial

- Herbaceous Vegetation
  - Mowed lawn
  - Field
  - Old field
- Scrub-Shrub Uplands
  - Early successional
  - Late successional
- Early Successional Deciduous Forest
- Mature Secondary Growth Deciduous Forest

ii) The identified Species of Concern for the Site are the American brook lamprey and the Ohio lamprey although there is no suitable habitat at the Site to support these two species.

iii) Two other Species of Concern potentially inhabiting the area are the American bittern and the osprey. However, there is no suitable habitat for either species present on or in the vicinity of the Site.

iv) All of the wetlands on the Site are identified as Habitats of Concern because they provide identified function and value. However, none are identified as "Exceptional Value".

Benthic Macroinvertebrate Study

i) Although some impairment of the aquatic community adjacent to the Site was noted (compared to the upstream control area), not all of the impairment is related to the refinery.

ii) No toxic response was indicated by the data.

iii) Petroleum was not noted to be present in the water column or the sediment of the Tunungwant Creek or its Tributaries.

iv) Habitat modifications and continuing habitat disturbances are concluded to be major factors limiting the distribution of Species of Concern and the quality of the stream as a Habitat of Concern.

v) Habitats of Concern and Species of Concern have not been significantly impacted by refinery operations.

vi) Kendall Creek and Bolivar Run were determined to be non-impaired.

vii) Foster Brook was determined to be moderately impaired but this is based upon a lack of suitable habitat; not as a result of impact from the Site.

viii) The benthic invertebrate community has improved or recovered since the PADEP survey conducted in 2000.

Screening Level Ecological Assessment – Steps 1 and 2

The SERA evaluated risk to ecological receptors posed by chemical constituents in the various areas of the Site. Some of the risk to ecological receptors posed by chemical constituents at the Site were in excess of the various ecological screening values for surface water, sediment, and surface soils. Consequently, it was necessary to continue to Step 3 of the USEPA's 8-Step ecological evaluation process. Many of the constituents carried forward to Step 3 did not exceed the ecological screening values, but simply had elevated detection levels (even though they were not detected). These constituents were carried forward to Step-3 as a precautionary measure. In Step-3, more Site specific characteristics were taken into consideration in the evaluation process.

In summary, a total of 17 surface water chemical constituents, 100 sediment chemical constituents, and 168 soil chemical constituents were carried forward to Step 3.

2.9.2 STEP 3 ECOLOGICAL RISK ASSESSMENT

In Steps 1 and 2, the most conservative ecological benchmark concentrations were identified as the ESV against which to assess each chemical constituent in each media (soil, sediment, and surface water). In the first phase of Step 3, ecological benchmark concentrations that are more appropriate for site-specific conditions (refinement benchmarks) were identified.

The evaluation performed in the first refinement phase of Step 3 identified five chemical constituents that were retained as COPECs in soil for the second phase of Step 3:

- 1,2,4-trimethylbenzene;
- 1,3,5-trimethylbenzene;
- bis(2-ethylhexyl)phthalate;
- 2-methylnaphthalene; and
- copper.

There were no chemical constituents that were identified as COPECs for either the sediment or for the surface water media.

These five chemical constituents were then further evaluated in the second phase of Step 3 using simple food chain models and wildlife indicator species to evaluate risk to various trophic guilds of ecological receptors.

Results of the food chain analyses showed that the potential for risk is within acceptable limits for the wildlife indicator species exposed to the COPECs in the soil in the Foster Brook Facility and Tunungwant Creek-Foster Brook Corridor.

One additional issue that was evaluated during the ecological risk assessment involved the observations of iron staining in the sediment of Tunungwant Creek. The results of the assessment performed showed that the iron staining may cause an adverse impact on the aesthetics of Tunungwant Creek. However, the potential for risk to ecological receptors due to iron in surface water and sediment was found to be within acceptable limits. Furthermore, the macroinvertebrate survey conducted as part of the SERA did not identify any impacts to the benthic community that could be attributed to iron or any other COPEC.

Based on the results of the refinement process and food chain analyses, it was concluded that the potential for risk to ecological receptors is within acceptable limits in all surface water, sediment, and soil media in all assessment areas at the ARG Facility. Consequently, there is neither need nor justification for a baseline risk assessment and the ecological risk assessment process can be exited at Step 3.

Given the absence of any identified unacceptable risk in any of the media, the ecological risk assessment for the ARG Facility is complete.

3.0 SUMMARY OF IMPLEMENTED AND PLANNED REMEDIAL ACTIONS

This section provides a summary of:

i) the remedial actions already implemented; and
ii) the remedial actions planned to be implemented.

3.1 IMPLEMENTED REMEDIAL ACTIONS

In summary, the remedial actions already implemented are:

i) The completed container removal program in the Refuse/Container Removal Area which has effectively remediated this area.

ii) The pumping of the horizontal wells (HW-1 through HW-10, inclusive), supplemented by select vertical wells (RW-2, RW-3, RW-4, RW-15, and RW-19) is effectively preventing the discharge of SPL and significantly reducing the flux of Site-impacted groundwater to Tunungwant Creek. This conclusion is based on the fact that between May 2003 and the end of March 2005, approximately 33,875,000 gallons of groundwater and 13,600 gallons of SPL was collected from these pumping systems. This conclusion is further supported by the minimal observed occurrences of seeps to the Creek via the flood control wall weep holes in the last year compared to previous years. It is noted that HW-8 became inoperable on March 23, 2007 due to construction activities. As shown on Figure 3.1, the area addressed by HW-8 is also addressed by HW-7 to the south and HW-9 to the north except for a short interval. The SPL in this interval is now being addressed by the use of vertical well MW-21.

iii) Construction of the new groundwater treatment facility was completed in April 2005 and the facility has been successfully operating since that time. The system is fully capable of meeting the PADEP permit discharge limits.

iv) A program of manual SPL recovery has been implemented at the Site and has significantly reduced the thickness and volume of SPL underlying the Site. Approximately 27,200 gallons of SPL have been recovered through the manual SPL Recovery Program to March 31, 2007.

v) Implementation of an IRM beneath the Foster Brook Facility attendant's station to ensure that the air space beneath the building will be the same as the ambient outdoor air and eliminate the soil gas to indoor air pathway.

The locations of the implemented remedial actions are shown on Figures 3.1 and 3.2.

One of the primary concerns that PADEP has expressed about the Site is the potential impact that groundwater seeps may have on the quality and aesthetics of Tunungwant Creek. These seeps are primarily located in the concrete flood control wall area and discharge from the weepholes at the base of the wall.

There are currently a number of remedial actions being performed to prevent SPL seeps into Tunungwant Creek. These are:

i) SPL impacted groundwater is being removed by the horizontal collector wells and vertical recovery wells located behind the flood control walls;
ii) manual SPL removal from monitoring wells in which SPL has been identified to be present;
iii) automated SPL/groundwater removal is occurring from select wells, typically resulting in larger SPL removals;
iv) monitoring for and addressing SPL seeps, if any (using absorbent pads, booms, etc.) along the shoreline to prevent entry into Tunungwant Creek; and
v) monitoring, reporting, and addressing sheens on Tunungwant Creek in accordance with the Consent Order and Agreement (COA).

The COA requires that visual inspections of the area of Tunungwant Creek shown on Figure 3.3 be conduced on a daily basis (or such other frequency determined by agreement between Chemtura, ARG, and PADEP) and that a log is to be maintained describing all observations, any petroleum, iron precipitate, and/or petroleum sheens, abatement actions taken, and the results thereof. The inspection log documents whether observed conditions are newly discovered or continuing from a previous observation, and documents possible or apparent causes and sources such as remedial system shut downs, precipitation events, creek stage, and non-Site related events.

A discharge of petroleum, iron precipitate, and/or petroleum sheens more than 25 feet in length or, in the judgment of Chemtura and/or ARG, likely to become more than 25 feet in length is immediately reported to PADEP. SPL observed accumulating or seeping from weep holes or stream banks which is greater than three feet in length is reported immediately to PADEP.

Within ten days after orally reporting a release of petroleum, iron precipitate, and/or petroleum sheens in Tunungwant Creek, Chemtura and/or ARG document such observations in a written report to PADEP ("Release Report"). Each Release Report includes a description of the release, the location of the occurrence, the measures that

Chemtura and/or ARG undertook, and/or are continuing to take, and the results thereof. If Chemtura and/or ARG do not take measures to address the occurrence, the Release Report includes the reasons for such inaction.

3.2 PLANNED REMEDIAL ACTIONS

The descriptions of the remedial actions planned to be implemented are provided below in two sections:

i) those to be implemented on the Site itself; and

ii) those to be implemented on properties adjacent to the Site which have been impacted by the Site.

3.2.1 SITE

The remedial actions planned to be implemented for the Site include the following:

i) continued operation of the horizontal and vertical collection wells;

ii) continued operation of the groundwater treatment system;

iii) continued implementation of the manual SPL recovery program;

iv) continued inspection and reporting of the Creek bank conditions, including mapping of the iron stained areas on an annual basis;

v) continued implementation of corrective actions to address any observed SPL or sheens noted during the Creek bank inspection;

vi) making HW-11 and HW-12 operational to address the SPL-5, SPL-6, and SPL-7 areas;

vii) excavation and off-site disposal of SPL-impacted soil from the SPL-16 area;

viii) in-situ oxidation to address the SPL-23 area;

ix) air sparging/soil vapor extraction (AS/SVE) to address the SPL-22, SPL-24, and SPL-26 areas; and

x) closure and monitoring of the five specific areas in the Foster Brook Facility.

In addition, a macroinvertebrate study and surface water sampling will be performed every two years, until such study/sampling can be stopped in accordance with the conditions provided in Section 3.c of the COA. It is noted that the surface water sampling is to be performed when flow conditions are equal to or less than 7Q10 or when conditions acceptable to PADEP exist.

The remedial actions for the Site have the primary objectives to implement an appropriate and cost effective solution to:

i) prevent further off-Site migration of contaminated groundwater which would result in exceedances of either SHS MSCs or SSSs at the point of compliance, *i.e.*, the downgradient impacted area property boundary;

ii) to the extent practicable, remove the SPL present on the groundwater at various locations throughout the Site to less than 0.01 feet (apparent thickness); and

iii) prevent exposure of the Site personnel and others working at the Site to unacceptable risks and/or hazards from the Site conditions.

A summary of the technologies selected in the SCR by groupings of technologies is provided below.

The selected technologies for SPL-1, SPL-4, SPL-9, SPL-20, SPL-21, SPL-27, and SPL-30 are:

i) manual SPL/groundwater recovery;

ii) natural attenuation; and

iii) institutional controls.

The recommended technologies for SPL-2/3, SPL-18, SPL-19, and SPL-31 are:

i) manual SPL recovery;

ii) manual SPL/groundwater recovery;

iii) natural attenuation; and

iv) institutional controls.

It is noted that the volume of SPL in SPL-31 has significantly diminished and it is planned to address the small residual that remains by using wells on the National Transit property rather than wells on the railroad property. The recovery of SPL may be enhanced with the possible use of vacuum pumping to accelerate the rate of SPL recovery.

With regard to SPL-18, a portion of this SPL area is attributable to the release of diesel fuel reported on May 24, 2004. SPL from this area will continue to be recovered as described in the Quarterly Status Reports prepared by ARG. In summary, SPL recovery is being performed using a dedicated SPL recovery system which operates continuously and vacuum pumping which is currently performed bi-weekly. The frequency of future vacuum pumping will be determined on an ongoing basis taking into consideration the volume of SPL recovered during each pumping event.

The recommended remedial technologies for SPL-16 are:

i) excavation;

ii) natural attenuation; and

iii) institutional controls.

The recommended technologies for SPL-23 are:

i) manual SPL recovery;

ii) in-situ remediation;

iii) natural attenuation; and

iv) institutional controls.

The recommended technologies for SPL-17, SPL-25, SPL-28, and SPL-29 are:

i) natural attenuation; and

ii) institutional controls.

It is noted that the SPL thickness in well MW-CR06 (SPL-17) was observed to have increased significantly in October 2006. Based on investigations performed by MACTEC in June 2007 on behalf of ARG, (see report titled "Site Characterization Report, Tank 720" dated December 6, 2007) it was identified that a new release has occurred from Tank 720. Based on the increased volume of SPL in this area due to this new release, the remedial technologies being used on an interim basis in the SPL-17 area have been expanded to include manual SPL recovery including vacuum pumping. It is noted that the detailed scope of the implementation of the SPL recovery are to be provided in a Remedial Action Plan prepared by ARG within 45 days of PADEP approval of the above referenced Tank 720 SCR.

The recommended technologies for SPL-10 are:

i) manual SPL recovery;
ii) vertical SPL extraction wells;
iii) horizontal collection wells;
iv) natural attenuation; and
v) institutional controls.

The recommended technologies for SPL-5, SPL-6, SPL-7, SPL-8, SPL-11, SPL-12/13, SPL-14, and SPL-15 are:

i) manual SPL recovery;
ii) horizontal collection wells;
iii) natural attenuation; and
iv) institutional controls.

The recommended technologies for SPL-22, SPL-24, and SPL-26 are:

i) manual SPL recovery;
ii) AS/SVE;
iii) natural attenuation; and
iv) institutional controls.

The above summary shows that the remedial measures to be implemented are a combination of two or more of the following technologies in each SPL area:

i) natural attenuation;
ii) manual SPL recovery;
iii) manual SPL/groundwater recovery;
iv) excavation;
v) horizontal collection wells;
vi) vertical SPL extraction wells;
vii) in-situ remediation;

viii) air sparging/soil vapor extraction; and

ix) institutional controls.

The selected technologies for each SPL area are listed in Table 3.1.

3.2.2 OFF-SITE AREAS

This section summarizes the planned remedial actions for the off-site properties adjacent to and/or downgradient of the Site.

In summary, natural attenuation and institutional controls are to be used for all off-Site properties, except for two areas; the portion of the B&P Railroad south of Kendall Avenue where manual SPL/groundwater recovery will be used and the portion of the B&P Railroad adjacent to EU3/EU8 where manual SPL recovery will be used.

With regard to the protection of the construction worker in implementing the planned remedial actions, procedures will be put in place to ensure that appropriate health and safety measures are implemented.

For the off-site private properties, procedures will be in place to ensure that ARG/Chemtura are notified of any subsurface activities that are planned and that an appropriate health and safety plan is available for and used for the activity. In addition, an agreement will be in place to preclude the use of groundwater.

The language for the planned agreement will be provided to PADEP when developed. The template for the health and safety measures was provided as Appendix AT in the July 2007 SCR.

3.2.3 CLOSURE ACTIONS - FOSTER BROOK FACILITY

Five areas in the Foster Brook Facility are to be properly closed in compliance with Pennsylvania laws and regulations. The activities to achieve proper closure are described below.

3.2.3.1 BAUXITE FILL AREA

The evaluations in the SCR showed that:

i) the bauxite fill is uncovered and friable and thus subject to erosion;

ii) benzene, ethylbenzene, and naphthalene exceeded SHS MSCs in the unsaturated soil; and

iii) benzene, arsenic, iron, and manganese exceeded SHS MSCs in groundwater.

Therefore, this area will be closed under a combined SHS MSC and SSS.

To properly close the Bauxite Fill Area, the following actions will be implemented:

i) minor regrading to achieve compliance, to the extent practical, with the slope requirements;

ii) placement of a geotextile overlain with a 6-inch thick crushed limestone cover to prevent contact;

iii) implementation of deed restrictions to restrict land and groundwater use and operating procedures to ensure appropriate H&S measures are implemented for subsurface activities; and

iv) inspections, monitoring, and maintenance (O, M&M).

Additional details regarding O, M&M for all five areas are presented in Section 5.1.

3.2.3.2 FLY ASH AREA

The evaluation in the SCR showed that:

i) no parameters exceeded SHS MSCs in soil;

ii) no groundwater analytical results are available. However, considering no exceedances of SHS MSCs occurred in the soil, it is unlikely that the groundwater has Site-related exceedances;

iii) the fly ash is covered with a 4 to 6-inch thick layer of clay/slag material with a slope of 1% or less. The cover appears to be controlling infiltration; and

iv) the cover is only partially vegetated and thus some areas are subject to erosion.

Because there are no exceedances of SHS MSCs, this area will be closed under the SHS MSCs.

To properly close the Fly Ash Area, the following actions will be implemented.

i) perform minor isolated vegetation removal, grubbing, and regrading to enhance precipitation runoff to Foster Brook;

ii) supplement the existing cover (where needed) with sufficient soil capable of supporting vegetation to achieve a minimum cover thickness of one foot;

iii) revegetate the Fly Ash Area with grasses and herbaceous seed mix to enhance the ecological value of the area; and

iv) inspections and maintenance.

3.2.3.3 FORMER BURN PIT AREA

The evaluations in the SCR showed that:

i) the area is completely vegetated with only a few small isolated bare spots;

ii) the ground surface is currently sloped at approximately 2% toward Foster Brook and the drainage swale of State Route 219;

iii) PAHs, BTEX, chlorinated VOCs, lead, and selenium were detected in soil at concentrations in exceedance of SHS MSCs;

iv) PAHS, benzene, ethylbenzene, chlorinated VOCs, arsenic, and manganese were detected in groundwater at concentrations in exceedance of SHS MSCs; and

v) most areas are covered with a 2 to 4 foot thick layer of clayey silt.

Because there are exceedances of SHS MSCs, this area will be closed under a combined SHS MSC and SSS.

To properly close the Former Burn Pit Area, the following actions will be implemented:

i) modest regrading of the existing 2 to 4-foot thick clayey silt cover to enhance precipitation runoff toward Foster Brook and the State Route 219 drainage swale. The grading will be performed to ensure that a minimum 1-foot thick cover will remain;

ii) supplement the existing cover (where needed) with sufficient soil capable of supporting vegetation to achieve a minimum cover thickness of one foot;

iii) revegetate with grasses and herbaceous seed mix to enhance the ecological value of the area;

iv) implementation of deed restrictions and appropriate H&S measures for subsurface activities; and

v) inspections, monitoring, and maintenance.

3.2.3.4 CONSTRUCTION DEBRIS AREA

The evaluations in the SCR showed that:

i) the area is partially vegetated (70% coverage);

ii) the fill, where present, is generally exposed at the ground surface;

iii) chlorinated VOCs, metals, and benzene were detected in the soil at concentrations in exceedance of SHS MSCs; and

iv) chlorinated VOCs, iron, manganese, nickel, and beryllium were detected in groundwater at concentrations in exceedance of SHS MSCs.

Because there are exceedances of SHS MSCs, this area will be closed under a combined SHS MSC and SSS.

To properly close the Construction Debris Area, the following actions will be implemented:

i) vegetation removal, grubbing, and regrading of uneven areas and regrading of open, non-vegetated areas to promote surface water drainage;

ii) cover all exposed wastes and regraded areas with a minimum 12 inches of soil capable of supporting vegetation;

iii) revegetate with grasses and herbaceous seed mix to enhance the ecological value of the area;

iv) implementation of deed restrictions and appropriate H&S measures for subsurface activities; and

v) inspections, monitoring, and maintenance.

3.2.3.5 CONTAINER/REFUSE REMOVAL AREA

The evaluations in the SCR showed that:

i) the previously completed container removal program has effectively remediated this area;

ii) the container removal area is partially vegetated (70% coverage);

iii) the rest of the area is completely vegetated;

iv) fill is exposed only in a small number of test pits and along a steep drop-off;

v) arsenic acetone, cobalt, lead, and thallium concentrations in soil very slightly exceeded SHS MSCs; and

vi) beryllium and nickel in groundwater very slightly exceeded SHS MSCs.

Because there are exceedances of SHS MSCs, this area will be closed under a combined SHS MSC and SSS.

To properly close this area, the following actions will be implemented:

i) minor vegetation removal, grubbing, and regrading to improve surface water drainage;

ii) cover all exposed wastes and regraded areas with a minimum 12 inches of soil capable of supporting vegetation;

iii) revegetate the newly covered and regraded areas with grasses and herbaceous seed mix to enhance the ecological value of the area;

iv) implementation of deed restrictions and appropriate H&S measures for subsurface activities; and

v) inspections, monitoring, and maintenance.

Drawings showing the existing topography, final grades, and cut/fill cross-sections are provided in Appendix I. Specifications for the soil material and geotextile are provided in Appendix J.

4.0 PREDESIGN, DESIGN, AND CONSTRUCTION CONSIDERATIONS FOR ELECTED REMEDIAL TECHNOLOGIES

This section provides the predesign activities and design and implementation/construction considerations for the selected remedial technologies.

4.1 NATURAL ATTENUATION/MONITORING

As shown in Table 3.1, this technology is to be used for all of the on-Site SPL areas principally as the final polishing step when active remedial technologies have achieved the limit of their effectiveness. This technology typically consists of a program to monitor groundwater conditions. Natural attenuation (NA) refers to a remediation that relies on the naturally occurring processes in soil and groundwater that act without human intervention to reduce the mass, toxicity, volume, or concentration of contaminants in those media. NA includes both destructive and non-destructive mechanisms. Natural bioremediation is the most prominent in situ destructive mechanism, while non-destructive mechanisms include adsorption, dispersion, dilution, and volatilization.

Bioremediation is a process whereby contaminants are metabolized into less toxic or nontoxic compounds by naturally occurring microorganisms present in the site soils and groundwater. The microorganisms utilize the contaminants as a food source. The by-products of this biological process frequently are carbon dioxide and water. Bioremediation can take place under aerobic conditions (with oxygen) or anaerobic conditions (without oxygen) in the presence of other suitable electron acceptors such as nitrate, sulfate, and carbonate. Native microorganisms that are already present at a site are called *indigenous*. If the indigenous bacteria present at a site are inactive or inadequate, they can be augmented by microbial cultures designed specifically for the treatment. Such bioaugmentation would involve active remediation. The need for bioaugmentation will be determined on an SPL by SPL area basis using the analytical results obtained from the groundwater concentration trend monitoring described in Section 6.0.

Natural attenuation does not directly address metals in the soil but may impact those in the groundwater such as iron and manganese. In most cases, the reason that naturally occurring metals are found at elevated levels in the groundwater is due to their dissolution due to a change in the geochemical stability balance. For example, a change has occurred at this Site due to the presence of the BTEX compounds. The BTEX compounds have consumed the available oxygen in the groundwater as part of the biodegradation process. Once the oxygen is consumed, the groundwater becomes anaerobic which results in the release of iron and manganese from the native soil particles into the dissolved phase. Consequently, iron and manganese at the Site are often found at elevated concentrations in the groundwater. As the BTEX compounds are removed, the oxygen demand in the soil and groundwater will decrease and the oxygen levels in the groundwater will return to background conditions which are more aerobic. This in turn is expected to result in lower iron and manganese concentrations in the groundwater.

4.1.1 PREDESIGN, DESIGN, AND IMPLEMENTATION CONSIDERATIONS

The effectiveness of natural attenuation as a viable remedial option was confirmed based on the laboratory treatability study performed by Wright (January 1993). Thus, there are no further predesign activities required for this technology. Furthermore, no design or implementation activities are associated with this technology, other than monitoring which is described in Section 6.0.

4.2 SPL RECOVERY

SPL recovery is being performed in many locations throughout the Site using various technologies. SPL recovery technologies include:

i) manual SPL recovery;
ii) vertical extraction wells; and
iii) horizontal collection wells.

All of the SPL recovery technologies have been implemented on Site and have been proven to be effective. Each of these SPL recovery technologies are discussed in the following subsections.

With the recovery of SPL there is the need to dispose of the SPL. In any case where SPL is recovered from one of the remedial systems, it will be recycled on-Site and converted into useful products. This has been ongoing at the Site for many years and has proved to be a valuable component of the interim remedies that have been implemented. The recovered SPL from future remedial systems will continue to be transferred to ARG for re-use at the refinery. Collected groundwater will be discharged into the Chemtura wastewater treatment plant (WWTP) for treatment prior to discharge to Tunungwant

Creek. This treatment plant has also been constructed as an interim remedial component and has been proven to be effective. If necessary, any future remedial option involving water collection may continue to make use of this viable resource.

4.2.1 MANUAL SPL RECOVERY

There are two primary forms of manual recovery: one in which primarily SPL is recovered and the second in which both SPL and groundwater are recovered. Both are described below:

In **Manual SPL Recovery**, the SPL is removed from vertical monitoring/recovery wells with minimal groundwater removal. The SPL is removed using a top-loading bailer, peristaltic pump, product only pump (e.g., Xitech) or other similar device to collect the layer of SPL that floats atop the groundwater table. This option is fairly easy to implement and has the advantage of minimal groundwater removal. While the area of influence over which SPL can be drawn to the well is limited and therefore recovers less SPL than an active recovery system, this technology is applicable for the reduction of the volume of SPL in SPL source areas.

In **Manual SPL/Groundwater Recovery**, the groundwater table is depressed using the available wells to enhance SPL flow toward the extraction point and thus enhance SPL recovery. Pneumatic or electrical submersible pumps are often used to depress the groundwater table in an SPL plume and the pumped fluids are transferred to a mobile oil/water separator (OWS). The SPL accumulates in the depression and can be recovered using a bailer or product only pump. Alternatively, dual phase pumps can be used to both depress the groundwater table and recover SPL. This method also has the ability to recover the dissolved constituents in the groundwater.

4.2.1.1 PREDESIGN, DESIGN, AND IMPLEMENTATION CONSIDERATIONS

Both of these methods of SPL recovery are in current use at the Site and are effective. No predesign, design, or construction activities are needed for these technologies since a sufficient number of wells already exist within each SPL area for SPL recovery.

The selection of which wells are to be included in the SPL recovery program and the frequency of removal is made on an ongoing basis taking into consideration the thickness of SPL measured in a well and the volume of SPL recovered from a well during each SPL removal event, with more frequent removal directly associated with a greater SPL thickness and/or larger volume removed per event. The same selection process is also used to determine in which wells the more aggressive manual SPL/groundwater recovery technology is to be used.

Another operational consideration that has been implemented for these technologies for the past four years, is a reduction in the extent of the manual SPL recovery during the winter months. This reduction is due to the difficulty in handling the recovered fluids when the temperature is below freezing.

4.2.2 EXTRACTION WELLS

Active SPL recovery using vertical extraction wells and horizontal collection wells, or a combination of these technologies are in current use at the Site and are effective. For the vertical well technology, no new wells and supporting infrastructure (e.g., forcemains, controls, etc.) are planned to be constructed. For the horizontal wells, it is planned to make the existing HW-11 and HW-12 operational. The discharge from the extraction wells is transported via forcemain to the existing Chemtura WWTP. This conveyance system is effective.

While the use of active SPL recovery in vertical wells was shown not to be sufficiently effective in creating a complete barrier to off-Site SPL migration, active SPL recovery from vertical wells located within the core (source) of an SPL plume has been shown to be effective in reducing the volume of SPL. The use of vertical wells has also been shown to be effective in supplementing the effectiveness of the horizontal well system. Currently, vertical wells RW-2, RW-3, RW-4, RW-15, RW-19, and MW-21 are being used to supplement the horizontal well system.

4.2.2.1 DESIGN CONSIDERATIONS

Directionally-drilled wells are wells that are installed horizontally or at an angle to reach contaminants not accessible by vertical wells. Because of their longer screened intervals, horizontal wells provide a larger surface area in contact with contaminated soil or groundwater, thereby allowing more effective collection of SPL and impacted groundwater. Most contaminant plumes travel with the horizontal groundwater flow. Therefore, horizontal wells typically provide more access to the plume than vertical wells. One horizontal well replaces the need for many vertical wells. Where access is an issue due to aboveground facilities (e.g., tanks , pipe racks, buildings, etc.) as in the case of the Main Refinery, horizontal wells were installed to address the SPL underlying these facilities.

Horizontal wells are an active SPL recovery method which draws down and collects impacted groundwater thereby also addressing the dissolved constituents that reside in the groundwater flow regime. Nine horizontal collection wells (HW-1 through HW-7, HW-9, and HW-10) are currently in operation in the Main Refinery. As described in Section 3.1, HW-8 became inoperative on March 23, 2007 and the SPL in the area formerly addressed by HW-8 is now being addressed by horizontal wells HW-7 and HW-9 and vertical well MW-21.

Each existing horizontal well at the Site is equipped with a pneumatically operated withdrawal system that draws groundwater and SPL via a suction line from within the horizontal well. The suction points are located to be consistent with the lowest points along the horizontal wells to create as effective a drawdown on the groundwater table as possible. The vertical alignment of the horizontal wells varies over the length of the wells as was necessary to circumvent various below grade structures (e.g., foundations, etc.) and other utilities. The intent of the wells was to be positioned for the minimum recovery of groundwater while optimizing the collection of SPL before it could discharge to the Creek via the flood control wall weep holes. The system became operational in 2000, and operating experience has shown that each well is typically capable of providing on the order of 2 to 5 gpm of groundwater and whatever SPL is present in the drawdown capture zone on a continuous basis. The volume of groundwater recovered is consistent with the hydraulic conditions within which the wells are set.

For the horizontal collection well technology, no new collection wells are planned to be installed. However, it is planned to make HW-11 and HW-12 operational as described below.

4.2.2.2 CONSTRUCTION CONSIDERATIONS - HW-11 AND HW-12

To make HW-11 and HW-12 operational, the following activities will be performed:

i) construct the pumphouses for HW-11 and HW-12;

ii) install and connect the diaphragm pumps to the air lines and forcemains;

iii) install the air lines from their termination point near the HW-1 pumphouse to the HW-11 and HW-12 pumphouses; and

iv) install cleanouts at 200-foot spacings in the existing forcemains. The existing forcemains were previously used for vertical SPL recovery wells in the area of HW-11 and HW-12.

The health and safety procedures described in the Health and Safety Plan (HASP) provided in Appendix F will be followed. With regard to operations and maintenance of the entire horizontal well system, the report titled "Operations and Maintenance Manual, Recovery and Treatment System" dated December 2002 has been prepared. With regard to the groundwater treatment system,(i.e., Chemtura WWTP) operation and maintenance activities are described in the report titled "Groundwater Treatment System Operation and Maintenance Manual" dated May, 2005. The discharge from the groundwater treatment system is monitored pursuant to NPDES Permit No. PA0222151.

4.3 IN-SITU SPL REMEDIATION

Another form of SPL remediation involves technologies that can be applied in-situ to destroy/eliminate the SPL. One such method of in-situ remediation involves chemical oxidation of the SPL. Chemical oxidation is an effective innovative technology for the in-situ treatment of organics in groundwater, soils, and SPL and is planned to be used for SPL-23.

4.3.1 DESIGN AND IMPLEMENTATION CONSIDERATIONS

The oxidizing agents most commonly used are potassium permanganate ($KMnO_4$), hydrogen peroxide (H_2O_2), and ozone (O_3). $KMnO_4$ is more effective when delivered in an aqueous solution, and it reacts throughout a wide range of pH (5-12). Besides CO_2 and water, the reactions yield primarily manganese dioxide (MnO_2). $KMnO_4$ is relatively inexpensive compared to the other oxidants when used to address smaller masses of chemical constituents and is readily available in large quantities. It is also easy and safe to handle.

Because of:

i) the ease and safety of handling;

ii) effectiveness for petroleum products; and

iii) no need for extensive infrastructure, the oxidant selected for this technology is $KMnO_4$.

Based on previous assessments performed by CRA at other sites, it has been identified that 10 pounds of $KMnO_4$ will be needed for each pound of organic chemical constituent. Thus, 220 pounds of oxidant are calculated to be needed for the 22 pounds of SPL estimated to be within SPL-23. To address the natural demand within the soil due to other organic components, an additional 220 pounds of oxidant will be used. Furthermore, treatability studies performed by CRA support that a 3 percent $KMnO_4$ solution by weight is an appropriate solution strength.

The oxidant will be injected using vertical wells because of the high density and the depth of refinery facilities. Due to the relatively permeable nature of the overburden in this area four injection wells will be installed in the SPL-23 area. Figure 4.1 shows the planned well locations. These wells are located near the perimeter of the SPL area. This layout will assist in preventing the SPL from being pushed outwards by the injection of the 3 percent solution.

The wells will be located at approximately the mid-depth of the approximately 6-foot thick unsaturated zone so that:

i) the oxidant would not be subject to depletion in the upper soil interval; and

ii) the underlying soil interval would aid in dispersion of the oxidant to greater areal extent thereby providing more contact between the oxidant and the SPL.

Each well will be constructed of 2-inch diameter schedule 40 PVC with a 2-foot long 20-slot well screen and flush jointed threaded risers. The risers will extend at least 3 feet above ground surface. ARG procedures require that the upper 6 feet be hand-augured or equivalent to ensure no underground utilities are present. Thus, the entire borehole for the well will be hand-augured due to the shallow depth to the groundwater. A Morie #2 or equivalent clean silica sand pack will be placed in the borehole annulus to approximately two feet above the top of the well screen. The remainder of the borehole will be filled with a bentonite seal to approximately the ground surface. Potable water will be added once the bentonite is placed to ensure hydration. Since these are temporary wells located within a secured facility, no protective stick-up casing or flush-mounted road box will be installed.

The surface seal will ensure that the potassium permanganate does not escape to the ground surface via the well annulus. The chemical oxidant will be transferred from a mixing tank by gravity using a flex hose connected to the well. Once the required volume has been accepted by the well, the tooling will be removed and moved to the next well.

The solution will be injected via the four new wells and the two currently existing monitoring wells MW-TF07 and MW-TF39. A total of approximately 1700 gallons of 3 percent event solution will be injected. This is equal to approximately 73 pounds of potassium permanganate per well.

O&M will consist of weekly SPL thickness monitoring for six weeks after the injections.

Short-term impacts would be limited to potential disruption of refinery operations and potential exposure to excavated soil and drill spoils during installation of the injection system. Such exposure will be addressed using the procedures described in the HASP (Appendix F). Excess drill spoils will be handled as described in Section 4.8.

4.4 AIR SPARGING/SOIL VAPOR EXTRACTION

Air sparging/soil vapor extraction (AS/SVE) is planned to be used for SPL-22, SPL-24, and SPL-26. It is a proven technology that can be easily implemented. Air sparging involves the injection of air below the level of the contamination in the groundwater flow regime. As the air rises through the impacted groundwater, it volatilizes the VOCs/SVOCs and lifts them with the air to the vadose zone where they can be collected and treated by vapor extraction techniques. The air also supplies oxygen to the saturated and unsaturated zone and thus promotes the in-situ bioremediation of the chemicals. For SVE, blowers are used to draw air from the wells, thereby moving air through the soils. The extracted air is either re-injected into the soil or exhausted to the atmosphere. Treatment of the extracted air is generally required prior to recirculation or exhaust to the atmosphere. Treatment options include carbon adsorption and combustion technologies.

The effectiveness of the SVE system is dependent upon the type and characteristics of the soils, the chemicals present, and the rate at which the air is moved through the soil. The majority of the chemicals of concern in the soils at this Site are relatively amenable to air stripping or SVE. However, relatively low permeability in some areas may reduce the effectiveness of an SVE system. High vacuum can be used to improve the effectiveness of SVE in low permeability soils. If light non-aqueous phase liquid (LNAPL) is present, SVE may provide vacuum enhanced recovery (VER), whereby the vacuum and air flow draw LNAPL to the SVE well for subsequent removal by a top loading pump or suction drop tube.

By coupling air sparging with SVE, the saturated zone (groundwater), the capillary fringe zone, and the vadose zone will all be treated at the same time. However, since air sparging typically results in water table mounding and aggressive mixing, which can cause the free product to migrate and increase the dissolved concentrations, LNAPL should be removed to the greatest practical extent prior to start-up of the air sparge component of an AS/SVE system.

This technology will also address the metals concentrations in the groundwater that occur naturally (i.e., iron and manganese). As the organic compounds are removed, the oxygen demand in the groundwater should decrease and the oxygen level should return to background conditions which are typically more aerobic. This in turn should result in lower iron and manganese solubility and concentrations. This technology will not necessarily address the other metals.

4.4.1 PREDESIGN PILOT STUDY

Field pilot studies will be performed to obtain data necessary to evaluate the AS/SVE remedial technologies.

The following sections present the objectives, setup, and procedures for the proposed field pilot studies. The data generated will be used to further evaluate the applicability of these technologies for the Site.

4.4.1.1 SVE AND AIR SPARGING PILOT STUDY

This section presents the proposed pilot studies that will be conducted to evaluate SVE alone and SVE in conjunction with air sparging. As described above, SVE is the process of applying a vacuum to the vadose zone soil to create a pressure differential and induce air flow in the subsurface soil. The air flow enhances volatilization of VOCs and acts as the transport mechanism, as air and VOCs are drawn to the extraction well and out of the ground for subsequent treatment. The air is then discharged to the atmosphere or recirculated back into the ground.

United States Environmental Protection Agency (USEPA) guidance documents for SVE technology evaluation state that compounds with relatively low water solubility and vapor pressures greater than 0.5 mm Hg are most readily extracted using SVE technology. The vapor pressures and Henry's Law Constants, which relate the partial pressures of compounds in air and their equilibrium concentrations in liquid, for the VOCs in the SPL-22, -24, and –26 areas are of sufficient magnitude for SVE to be considered as a potential remedial technology.

In order to evaluate the applicability of SVE/AS for these areas, it is proposed that two studies be performed. One SVE/AS pilot study will be conducted in an area that does not have significant SPL. A second study of SVE only will be conducted in an SPL area to evaluate the potential for VER prior to air sparging. These technologies are considered complementary and could be used simultaneously in some portions of the SPL areas.

It is proposed that the SVE only pilot study be performed in the SPL-26 area in the vicinity of MW-TF02 and the SVE/AS study be performed in an appropriate location southwest of the SPL-26 area. Although groundwater samples have not been collected specifically in this area, it is anticipated that high concentrations of Site-related parameters will be present in the groundwater at these locations. The proposed locations for the pilot studies are presented on Figure 4.2.

4.4.1.2 PILOT STUDY OBJECTIVES

The objectives of the SVE pilot study are to evaluate the effectiveness of SVE technology for remediation of unsaturated Site soils and to collect information for use in the full-scale design. Key parameters to be evaluated include:

i) air flow rates and corresponding vacuum;
ii) soil air permeability;
iii) vacuum radii of influence;
iv) pore volume calculations; and
v) mass removal rates.

The objectives of the air sparging pilot study are to evaluate the feasibility of this remediation technology for the Site groundwater and collect information to aid in the full scale design. Parameters to be evaluated include:

i) air flow rates and sparge pressures;
ii) vapor concentrations of VOCs and oxygen;

iii) radius of influence by vacuum/pressure influence, groundwater mounding, dissolved oxygen, and VOC concentrations in groundwater;

iv) the influence of air sparging on SVE mass removal rates; and

v) reduction in groundwater VOC concentrations.

Potential vapor treatment requirements, and construction and operational limitations and considerations will also be evaluated based on pilot study observations and results.

4.4.1.3 SYSTEM INSTALLATION AND EQUIPMENT

SVE Wells

One 4-inch diameter vapor extraction well will be installed within each of the pilot study areas to depths of approximately 9 to 11 feet below ground surface (bgs). The bottom of the SVE extraction well for the AS/SVE study will be screened just above the water table, while, for the SVE only study, the bottom of the screen will be set at the bottom of the SPL layer. A minimum 8-inch diameter borehole will be required to properly construct and install the SVE only well. For the AS/SVE study, two separate wells (one for sparging and one for extraction) will be installed in the same borehole. In order to accommodate both wells, a minimum borehole diameter of 10 inches will be required. The vapor extraction wells will consist of 4-inch diameter flush joint threaded Schedule 40 polyvinyl chloride (PVC) casing and factory slotted well screen. Typical SVE extraction well details are presented on Figure 4.3. The well screens will be approximately 5 feet in length with 0.02 inch (20 slot) slotted openings.

A filter pack consisting of a uniformly-sized clean coarse sand will be placed around the screen. A bentonite seal, at least 3 feet thick, will be placed above the well screen on top of the filter pack. The remainder of the annulus will be backfilled to within 6 inches of the ground surface with a cement/5 percent bentonite grout mixture. The material used to complete the top 6 inches of the borehole will match the surrounding surface conditions.

A 4-inch to 2-inch bushing and 2-inch NPT coupling will be attached to the top of each well casing. If necessary, a surface-mounted protective well cover will be placed around the top of the well head. A cement apron will be placed around and shaped to slope away from the protective casing to allow for drainage away from the well.

Air Sparging Well

An air sparge well will be located in the same borehole as the SVE well and will be installed into the saturated zone with the sparge point installed at a depth of approximately 20 feet below the groundwater table. This depth was selected based on the SCR findings, which showed that the SPL had impacted only the upper 10 feet of groundwater. The additional 10 feet of depth will account for annual fluctuations in the groundwater table and allow for additional horizontal distribution of the injected air. Figure 4.4 shows the recommended installation details for the well. The main well casing for the air sparge wells will consist of 1-inch diameter Schedule 80 PVC. The bottom 3 feet of the well will be screened and sand packed and overlain with a minimum 3-foot thick bentonite seal. The remaining interval up to 1 foot below the underside of the extraction well will be backfilled with cement/5 percent bentonite grout.

SVE Monitoring Probes

Six monitoring probes will be installed to measure the horizontal distribution of vacuum within the vadose zone during the SVE only pilot study. The monitoring probes will be installed in three sets of two probes at radial distances of 10 and 30 feet (2 sets) and 20 and 40 feet (1 set) away from the extraction well. Each set will be installed approximately 120 degrees from the other sets around the SVE well. Each probe will be constructed of 1-inch diameter Schedule 40 PVC with a 2-foot long 0.01-inch (10 slot) slotted screen centered at approximately 7 feet bgs. Typical monitoring probe construction details are presented on Figure 4.5. A nominal 4-inch diameter borehole will be drilled for construction of each monitoring probe. A filter pack consisting of a uniformly-sized coarse sand will be placed around each monitoring probe screen and to at least ½ foot above and below the probe screen. A hydrated bentonite seal, at least 1 foot thick, will be placed above the sandpack. The top of each probe will be equipped with a ¼-inch sample port. A vacuum gauge will be attached to these fittings to monitor vacuum response during the pilot study. The sample ports will remain closed when not in use. The remaining annular space for each borehole will be backfilled to ground surface with a cement/5 percent bentonite grout and finished to match the surrounding surface conditions in the uppermost 6 inches.

Alternatively, if soil conditions are acceptable, drive-point vapor monitoring screens may be installed by direct push technique to similar depths and at locations consistent with the augered borehole installations described above.

Air Sparging Monitoring Piezometers

For the AS/SVE study, six monitoring piezometers will be installed to measure the horizontal effects of air sparging in the aquifer and SVE in the vadose zone. The monitoring piezometer clusters will be installed at the same radial distances and spacings described above for the SVE monitoring probes. Each piezometer will be constructed of 2-inch diameter Schedule 40 PVC with a 10-foot long 0.02-inch (20 slot) slotted screen installed such that at approximately 3 feet of screen is above the water table.

A nominal 4-inch diameter borehole will be drilled for construction of each piezometer. A filter pack of uniformly-sized coarse sand will be placed around each screened interval to at least 1 foot above and below the screen.

A bentonite seal at least 5 feet thick will be placed above the sand pack.

The remaining annular space for each borehole will be backfilled to within 6 inches of the ground surface with cement/5 percent bentonite grout and finished with material that matches the surrounding surface conditions.

Typical monitoring piezometer details are presented on Figure 4.6.

Soil Vapor Extraction Equipment

Mobile soil vapor extraction pilot equipment capable of generating a suitable range of air flow rates and vacuums will be provided for the duration of the pilot study. The anticipated equipment will include an explosion-proof high vacuum blower capable of 60 cubic feet per minute (cfm) at 100 inches w.c. vacuum, a 30-gallon moisture separator, flow meter, piping, valves and gauges, and vacuum monitoring gauges. Extracted vapor will be treated through two 200-pound activated carbon beds operating in series to minimize the potential for discharge of VOCs or nuisance odors to the atmosphere. It is expected that the pilot study will qualify for exemption from Plan Approval and Operating Permit. A Request for Determination will be submitted to PADEP to confirm this exemption prior to installation and testing.

Air Sparging Equipment

Portable air sparging equipment will be provided for the duration of the pilot study. The equipment will include a rotary vane compressor, controller and timer, flow indicator, and miscellaneous gauges and piping. Figure 4.7 shows a conceptual layout of the AS/SVE pilot study systems.

4.4.1.4 OPERATING PROCEDURES

Procedures for SVE Pilot Study

It is anticipated that SVE pilot study will be conducted for a minimum 2-week period on each SVE well. Initially, the unit will be operated for 1- to 2-hour durations at various flow rates for the purpose of selecting the appropriate flow rate for the full 2-week test (based on SVE flow rate and wellhead and monitoring probe vacuum levels). The unit will be operated at the selected flow rate throughout the study.

The vacuum response at each of the six monitoring probes, the extraction well air flow rate, vacuum, and relative hydrocarbon concentrations as measured using a flame ionization detector (FID), and barometric pressure will be monitored during the study period. Monitoring probe vacuum response will be recorded at 1-minute intervals during the first 15 minutes after start-up. All parameters will be measured in accordance with the following schedule:

i) at 15-minute intervals for the first 2 hours after initial start-up of the system and hourly for the next 4 hours;
ii) daily (at 24-hour intervals) for the next 2 days following initial start-up; and
iii) after the first and second weeks of operation (end of study).

Air samples will be collected from the soil vapor blower discharge line. The line will be tapped, and a sample port will be installed in the line. The sample port will be connected to the inlet of the field FID for direct VOC measurement in the field. Air samples will also be collected for laboratory analyses of VOCs. A total of four air samples will be collected for each of the SVE tests in accordance with the following schedule:

i) at initial start-up of the SVE system, after FID level stabilizes;
ii) 1 day after start-up;
iii) 1 week after start-up; and
iv) at the end of the 2-week study.

The samples will be analyzed for VOCs using USEPA Method TO-15.

In addition, the indoor air in nearby buildings will be monitored using the FID. If a reading significantly greater than the outside ambient air is obtained, an indoor air sample will be collected and analyzed for VOCs.

During the study in the SPL-26 area, (and in the AS/SVE study area if SPL appears during testing) the presence and thickness of an SPL layer will be monitored. As practicable, SPL will be recovered on a daily basis using a peristaltic or top-loading pump. The volumes of SPL recovered will be recorded and considered in the mass removal evaluation.

Procedures for Pilot AS/SVE Study

The air sparging pilot study will be performed in two phases. The first phase will be conducted for a 2-day duration to evaluate the flow rates and pressures required for sparging and the localized effects on surrounding groundwater and the vadose zone above the sparge point, and to select operating conditions for the longer term second phase study.

The second phase study will be conducted at the selected pressure and flow rate for a period of approximately 1 month. The SVE system will be operated during this phase of the air sparging study to compare mass removal with the removal observed during the SVE only study.

Air Sparging Study Procedures

The air sparging study will be performed after the individual SVE studies have been completed and baseline monitoring and sampling have been completed. The system will be started, and the sparge pressure will be increased gradually until the selected flow rate is established.

During the study period the following parameters will be monitored:

i) sparge flow rate and pressure at the injection well; and

ii) pressure, dissolved oxygen, groundwater elevations, headspace oxygen, and headspace relative hydrocarbon concentration by FID in the monitoring piezometers.

The above parameters will be monitored:

i) prior to the start--up of the study;

ii) twice daily for the first 2 days of operation; and

iii) every 3 days (twice per week) until the end of the study period.

Water samples will be collected from the sparge well and six monitoring piezometers, prior to start-up, and weekly until the end of the study period. The sparge blower will be temporarily turned off for collection of the sparge well water sample and turned on immediately after sample collection. Samples will be analyzed for Target Compound List (TCL) VOCs.

After 1 week of air sparging operation, the SVE system will be restarted. SVE monitoring and sampling will be performed similar to the SVE pilot study described previously with the following modifications:

i) vacuum response will not be measured at 1-minute intervals;

ii) headspace oxygen will be measured in the SVE off-gas and four monitoring probes at the same frequencies as other parameters; and

iii) vapor samples will be collected at SVE start-up, after 1 day of SVE operation, and weekly until the end of the study.

4.4.1.5 PILOT STUDY DATA ANALYSIS

Data collected during the SVE and air sparging pilot studies will be evaluated to assess the suitability of these technologies for the Site and, if appropriate, to determine the necessary design parameters for full-scale design. The following presents the methodologies that will be used to evaluate the pilot test data.

4.4.1.6 SVE PILOT STUDY DATA

Air Flow Rate Versus Vacuum

An air flow rate versus vacuum curve will be constructed to select the most desirable operating range for a full-scale system. The selection will allow for proper sizing of equipment to minimize capital and operating costs of the full-scale system.

Radius of Influence

The radius of influence for each pilot study will be estimated based on the vacuum response measured at the various monitoring probes and past experience gained from operating SVE systems in similar soils. A probe response of 0.5 to 1.0 percent of the applied SVE wellhead vacuum is generally considered significant in radius influence estimation. Other factors such as soil heterogeneity, moisture content, and potential short circuiting of air from the ground surface will be considered, as appropriate.

Soil Permeability to Air Flow

Two mathematical models can be used to calculate soil permeability to air flow. One model uses steady-state conditions at the SVE wellhead; the other model uses transient pressure response at the vapor probes. The simplistic steady-state radial flow solution for compressible flow can be used to estimate air permeability using the extracted flow rate and the following equation (Johnson, et al 1988)[1].

$$\frac{Q}{H} = P_w \pi \left(\frac{k}{\mu}\right)\left[\frac{1-(P_{Atm}/P_w)^2}{\ln(R_w/R_I)}\right]$$

Where:

Q/H	=	flow unit per length of well screen
k	=	soil permeability to air flow [cm²]
µ	=	viscosity of air = 1.8 x 10-4 g/cm-s
P_w	=	absolute pressure at extraction well [g/cm-s²]
P_{Atm}	=	absolute ambient pressure 1 x 10^6 g/cm-s²
R_w	=	radius of vapor extraction well [cm]
R_I	=	radius of influence of vapor extraction well [cm]

In addition to the steady-state method described above, the transient pressure distribution data in the soil media at a constant extraction flow rate may be used to estimate soil permeability to air flow. The change in subsurface pressure distribution with time P' (r,t) can be approximated (Johnson, et al 1988) by:

1 Johnson, P.C., M.W. Kemblowsi, J.D. Colthart, D.L. Byers, and C.C. Stanley. *A Practical Approach to the Design, Operation and Monitoring of In-Situ Soil Venting Systems*, 1988.

$$P' = \frac{Q}{4\pi m\left(\frac{k}{\mu}\right)}\left[-0.5772 - \ln\left(\frac{r^2 \varepsilon\mu}{4kP_{atm}}\right) + \ln(t)\right]$$

Where:

P'	=	"gauge" pressure measured at distance r[cm] and time t[sec]
m	=	stratum thickness [cm] (120 to 610 cm)
r	=	radial distance from vapor extraction well [cm]
k	=	soil permeability to air flow [cm^2]
μ	=	viscosity of air = 1.8 x 10-4 g/cm-s
ε	=	air-filled soil void fraction = 0.3
t	=	time [sec]
Q	=	volumetric vapor flow rate from extraction well [cm^3/sec]
P_{atm}	=	ambient atmospheric pressure 1 x 10^6 g/cm-s^2

Use of the equation requires that a number of vacuum readings be taken within the first several minutes of operation. The equation, plotted as P' vs. ln(t), typically results in a straight line with the slope A as a function of soil permeability:

$$k = \frac{Q\mu}{4A\,\pi m}$$

<u>Mass Removal Rates</u>

Vapor concentrations at start-up are representative of equilibrium vapor concentrations in the soil matrix, while concentrations observed after extended operation are more indicative of expected long-term removal rates. Based on long-term removal rates and the baseline contaminant mass present at the Site, SVE treatment duration and off-gas loading and treatment costs can be estimated. SPL removal data will be evaluated with respect to the effect of SVE on product recovery and potential long-term mass removal rates.

4.4.1.7 AIR SPARGING PILOT STUDY DATA

Sparge Flow Rate Versus Pressure

The required pressure and resultant sparge flow rate will be scaled up for full-scale design estimation. The information will allow for proper sizing of an air delivery system and other associated equipment.

Radius of Sparge Influence

The radius of influence for air sparging will be estimated based on pressure, dissolved oxygen, and headspace oxygen and FID concentrations at the monitoring probes and piezometers and the results of groundwater sampling in the pilot study area wells.

Mass Removal

Mass removal by air sparging will be estimated and compared based on changes in groundwater concentrations during the study and changes in SVE removal rates due to sparging. In this manner, the additional removal due to sparging can be compared to removal by SVE alone.

Mass removal estimates will be used to evaluate vapor treatment requirements and potential treatment technologies.

4.4.2 DESIGN AND IMPLEMENTATION CONSIDERATIONS

Implementation of this technology would require installation of sparge wells advanced to a depth situated below the elevation where the contamination resides. Because of the high groundwater table which results in a thin unsaturated zone and the lower permeability of the upper fine-grained soils at this Site, a fairly extensive network of vertical SVE wells may be needed to capture the sparged VOCs/SVOCs before they would be forced out into the open atmosphere. The layout of the wells will take into consideration interferences from both above ground and subsurface structures and utilities. The results of the pilot studies will be used to finalize the SVE well locations. To increase the effectiveness of the SVE system, a layer of low permeable material (e.g., compacted crushed limestone, poly sheeting, etc.) may also be placed on the ground surface in some areas.

An AS/SVE system will involve the use of an air compressor unit to inject air into the saturated zone and a vacuum blower, to extract air from the unsaturated zone. The extracted air would be treated using granular activated carbon or catalytic oxidation, prior to discharge to the atmosphere. The type of air treatment system will be evaluated using the results of the pilot study. The injection wells would be manifolded to the air compressor unit and the SVE wells would be manifolded to the blower unit.

It is noted that it is not typically prudent to employ air sparging of the groundwater until the SPL has been reduced to essentially a residual thickness. The reason for this is that air sparging, even with SVE in operation, may cause the SPL to migrate (spread-out) to areas which currently do not have SPL present. Chemtura has been removing SPL from this area for over three years to insure that the SPL has been reduced to a residual thickness. Consequently, no problems are expected for this application. This technology is relatively easy to implement, and relies on conventional construction methods and materials.

Excess soil generated during installation of the wells for the SVE system would be handled using the procedures described in Section 4.8.

Operation and maintenance will include maintenance of the AS/SVE and air treatment systems in accordance with the manufacturer's requirements. The scope of air and soil gas monitoring (including air discharges) will be developed during the design of the AS/SVE system.

Short-term impacts would be limited to handling of the soil in which the SVE components would be installed. Such exposure will be addressed using the HASP (Appendix F).

4.5 EXCAVATION AND OFF-SITE TREATMENT/DISPOSAL

Excavation and off-site treatment/disposal is planned to be used for SPL-16. This technology involves the excavation and removal of the source area (i.e., SPL and contaminated soil), which will then be transported off-Site for treatment and/or disposal to an appropriate licensed facility in accordance with applicable regulations. The excavated area will then be backfilled with excavated material suitable for use as backfill (i.e., clean fill) and if needed, clean imported fill. Excavation and soil handling will be performed using backhoes, trucks, roll-offs, and other conventional construction equipment, methods, and materials.

Excavation and disposal is an effective technology for treatment of the heavily impacted soils in a source area. Removal also addresses the soil and SPL to groundwater pathway by removing the source of chemicals to the groundwater. With chemicals no longer leaching to the groundwater, the chemical concentrations will decrease in the groundwater. The concentrations in the groundwater will further decrease due to natural attenuation. Thus, no further active groundwater remediation will be needed in this area.

4.5.1 DESIGN AND CONSTRUCTION IMPLEMENTABILITY CONSIDERATIONS

Implementability is expected to be relatively easy because of the sparsity of structures and underground utilities in this area and the fact that the SPL is above the groundwater table. Excavated soil overlying the SPL-impacted soil will be stockpiled for use as backfill. The excavated area will be backfilled to a uniform grade matching the existing surface area using the stockpiled soil or other imported clean soil. Prior to using imported soil for backfilling, the supplier will be requested to provide certification that the soil complies with PADEP's Clean Fill Policy. The surface cover will be made consistent with the surrounding conditions, which in the area of SPL-16 consists of either vegetated loam soil or granular roadway. Erosion and sediment control of the stockpiled soil and the regraded/filled area will be implemented pursuant to the Draft Erosion and Sediment Control Plan (see Appendix E) and the Draft Post-Construction Stormwater Management Plan (see Appendix K).

Potential short-term impacts that would need to be addressed are exposure to SPL, soil, groundwater, and odor and dust generation during excavation. The Site's HASP will be implemented to protect the construction workers from these potential exposure pathways.

The relatively small volume of soil containing SPL (i.e., 100 cubic yards based on corrected thickness) supports this as being a viable option. It is proposed to dispose of the SPL-impacted soil at either the Onyx-Veolia Landfill located near Dubois, Pennsylvania or at the McKean County Landfill. No O&M is required for this option.

4.5.2 DEMONSTRATION OF ATTAINMENT

In accordance with §250.707(b)(1)(B)(I), for sites being remediated under an NIR, five soil samples are to be collected from the bottom and sidewalls for excavations with soil volumes of 250 cy or less. The sample locations will be biased on areas where any remaining contamination above the applicable criteria would most likely be present. Such areas will be determined based on visual observation and the use of a PID with an 10.6 eV lamp. The samples will be analyzed for VOCs.

4.6 CLOSURE ACTIONS - FOSTER BROOK FACILITY

4.6.1 DESIGN CONSIDERATIONS

For the five areas to be closed in the Foster Brook Facility, the new soil covers will comply with the minimum slope requirements of 3 percent, the extent practical. However, there are some areas where this is not practical due to the need to match into the elevations of existing structures.

Some clearing, grubbing, and pregrading of the areas to be covered will be implemented to achieve compliance to the extent practical with the slope requirements. To assist in reducing the quantity of infiltration through the installed cover, it is planned to remove all the trees in the areas to be covered and not to replant the trees as tree roots growing through the cover could provide pathways of increased infiltration. The cleared vegetation will either be disposed off-site or chipped and used on-site for landscaping purposes. Stumps and roots located at an elevation above the pre-final grade (i.e., 12 inches below final grade) will be removed and disposed off-Site. It is expected that no excess soil will be generated by the pregrading activities.

PADEP has requested that low permeable soil be used for the covers to decrease the quantity of precipitation infiltration through the covers to the underlying impacted soils. In accordance with this request, it is planned to use silt-based soils for the soil covers and crushed limestone for the Bauxite Fill Area. Silt-based soils were selected rather than clay-based soil because clay-based soils are subject to desiccation cracking during dry periods. Such desiccation cracks would provide pathways for rapid infiltration prior to their natural resealing upon again becoming moist.

To further enhance the ecological value of the area, the seed mix to be used for the vegetative cover will consist of shallow rooted grasses, wild flower, and herbaceous seed mix.

4.6.2 CONSTRUCTION/IMPLEMENTATION CONSIDERATIONS

To reduce the risk of chemical transfer from one area to the next, the areas will be covered in sequence from those that have the least risk of exposing impacted soil to those with the greatest risk. Based on the SCR findings and the scope of work for each area the proposed order of cover placement is:

i) Bauxite Fill Area;
ii) Fly Ash Area;
iii) Former Burn Pit Area;
iv) Construction Debris Area; and
v) Container/Refuse Removal Area.

Erosion and sediment control during construction will be implemented pursuant to the Draft Erosion and Sediment Control Plan (see Appendix E) and after construction by the Draft Post-Construction Stormwater Management Plan (see Appendix K).

Pursuant to discussions with representatives of McKean County, the Plans will be provided to the County approximately 4 to 6 months prior to the start of construction. The County will review and it is anticipated that they will thereafter issue the letters of consistency required pursuant to Section C of the NOI.

To assist the establishment of the vegetative cover, the work will be scheduled such that seeding will occur in late August to early September. This is a preferred time of year for vegetative growth.

Solid residues from equipment decontamination generated prior to placement of the cover to be installed in the Container/Refuse Removal Area will be placed in the Container/Refuse Removal Area. Solid residues generated after cover placement in the Container/Refuse Removal Area will be handled as described in Section 4.8.

4.7 INSTITUTIONAL CONTROLS

Irrespective of which remedial option is selected, other than the excavation and disposal option, removal of the SPL to the extent practical and attainment of the MSC SHSs or SSSs will require some period of time. During this time period, ICs, as described below, will be used to prevent unacceptable exposure to the remaining contaminants.

Institutional controls (ICs) are used for areas that require restrictions on the future use of the Site. When contaminated sites are remediated to risk-based standards (e.g., SSSs), ICs are relied on for protection from exposure to any remaining contaminants and to maintain the integrity of the remedy. ICs must remain effective over the lifetime of the risk in order to achieve these objectives. ICs will be used to limit what kind of structure is built on a piece of property, to limit the type of facility that can be built or how it may be used, to limit the use of groundwater, and to restrict excavation or other specific activities that might cause human exposure or harm part of the engineered remedy.

Based on Site conditions and the results of the human health risk assessment, the primary institutional control for the Refinery property will be a deed restriction which:

i) prevents the on-site use/removal of groundwater except for remediation or monitoring purposes;

ii) restricts excavation unless appropriate soil management and necessary health and safety procedures are implemented; and

iii) requires a consideration of the need for controls to meet indoor air quality criteria for all existing and new buildings.

Chemtura will use the draft language included in Appendix B as well as the health and safety procedures contained in Appendix C. ARG has indicated its willingness to record a deed restriction with respect to the Refinery property based upon the draft language in Appendix B.

Chemtura and ARG will seek to have all holders of any easements or rights-of-way in the Refinery property join in the execution of the restrictive covenant so that it applies to the holders' property interests as well. If that effort is unsuccessful, initial contact will be made with each holder within two months of recording the deed restriction. Chemtura will explain the basis of the need for such restrictions and will provide the holder and other potentially interested parties with a written notice and warning of the potential adverse consequences that could result from non-compliance. Chemtura/ARG will also post appropriate warning signs adjacent to the easement or right-of-way. Thereafter, on an annual basis, a letter will be sent to each holder reminding that such restrictions exist and the holder will be requested to identify any upcoming work in the next year that could potentially be subject to the restrictions. A copy of the letters will be kept on file. Considering that the Refinery is operational and many areas require a sign-in for access, it is unlikely that work on an easement/right-of-way could be undertaken without being observed by ARG personnel. The restrictive covenants and related measures, if necessary, should be effective in eliminating any potential exposure pathways due to residual contaminants in the soil or groundwater.

Implementation of these restrictions will run with the land and will be included in the description of the property in deeds for all future conveyances or transfers of the property. Use of these institutional controls will control the exposure pathways identified in the SCR by eliminating the use of groundwater at the Site, require adherence to strict health and safety practices to minimize uncontrolled contact with site contaminated subsurface media, and specifically requiring that construction of buildings on the property to include use of measures to limit exposure to indoor air issues which may be associated with site conditions.

Uniform Environmental Covenants Legislation. Pennsylvania adopted the Uniform Environmental Covenants Act (UECA) on December 18, 2007. The UECA is officially "Act 68 of 2007" and becomes effective on February 19, 2008. Act 68 strengthens and expands the effective use of restrictive covenants at both the Refinery property and the adjacent properties that have been impacted by releases at the Refinery. For example, under Act 68, PADEP and/or Chemtura can be the grantees or holders of the covenant with the corresponding authority to enforce the covenant. Since the UECA has been adopted in Pennsylvania prior to the execution and recording of the covenants proposed herein, Chemtura/ARG expect to modify the proposed covenants to conform to and take advantage of the Act 68 provisions and are awaiting the guidance and model deed language being prepared by PADEP.

Institutional Controls for Non-Refinery Properties. Institutional controls are a component of the remedial options considered/recommended for each of the adjacent non-Refinery properties identified as being impacted by releases at or from the Refinery. Chemtura/ARG recognize that recommending ICs as a remedial option for adjoining properties presents two challenges: (1) convincing the property owner to agree to the imposition of a restrictive covenant, or cooperative agreement; and (2) constructing a restrictive covenant or cooperative agreement that will effectively achieve its intended purpose.

Based on the results of discussions held to date, Chemtura/ARG believes that the owners of adjacent properties are unlikely to agree to the recording of a restrictive covenant against their properties. However, they may be willing to sign a cooperative agreement which will allow Chemtura/ARG to participate in subsurface activities on the adjacent properties. Depending on the ownership and the circumstances at any particular property, Chemtura also recognizes that other incentives may be necessary or appropriate.

Since Act 68 has been adopted by the Pennsylvania Legislature, Chemtura/ARG expect to develop a form of restrictive covenant that would name Chemtura, ARG, and/or the Department as grantees with full authority to enforce the terms thereof. Failing agreement on the use of that restrictive covenant, Chemtura would propose to use a cooperative agreement similar to the one provided in Appendix D. The use of either the proposed restrictive covenants or cooperative agreement in combination with the provisions in CERCLA § 107(q) should result in effective institutional controls. A reference to the recorded declaration will be added to any subsequent deed conveying the property, if the off-Site property owner agrees to such.

The interim health and safety measures to be implemented during the negotiation period are:

i) Assist off-site property owners during pre-bid meetings and provide a template of a HASP (i.e., Appendix AT of the July 2007 SCR) to address Health and Safety issues for subsurface work;

ii) Perform periodic inspections (i.e., semi-annually) of the off-Site properties to visually identify activities which may result in unacceptable exposure and follow-up with the property owner if such are identified;

iii) Submittal of annual letter requesting property owner to identify any upcoming work in the next year that could result in potential exposure;

iv) Include reminder in annual letter that Chemtura/ARG are available to assist the owners to ensure that appropriate health and safety measures are taken for any upcoming subsurface work;

v) Continue working with owners to have appropriate postings/notices in place in case any subsurface work is required; and

vi) Assist property owners with handling of water and soil adversely impacted with SPL/chemicals attributable to the Site.

If, however, Chemtura is unable to obtain an adjoining property owner's consent to the imposition of a restrictive covenant against the property in question or enter into a cooperative agreement or it is determined that any restrictive covenant granted by or cooperative agreement entered into with the property owner is inadequate or ineffective in eliminating the potential exposure pathway(s) of concern, Chemtura recognizes that it will need to evaluate other remedial alternatives and select and implement a remedial action that will effectively address the exposure pathway(s) of concern.

If a restrictive covenant will not be granted or an acceptable cooperative agreement cannot be entered into with an owner(s) of an adjacent property, the interim health and safety measures described above will continue to be implemented.

In addition, ARG/Chemtura are pursuing the option of becoming registered under the underground utility "One Call" system. The system would notify ARG/Chemtura when a party has applied for a utility clearance within the Town of Bradford/Foster Township, near the refinery.

The effectiveness of the Institutional Controls will be evaluated on an annual basis for the first three years and then once every two years until the requirements of the COA have been met. The evaluation will be done in conjunction with the feedback received from the off-Site property owners with regard to the letter sent out annually to the off-Site property owners.

4.8 EXCAVATED EXCESS SOIL AND WASTE HANDLING

The soils may be temporarily placed in a stock-pile, roll-off, or other suitable container until the works creating excess soils for that particular construction campaign are completed.

The only activities which are anticipated to create excess soil are:

i) cuttings from AS/SVE and monitoring well installations;

ii) excavation of the SPL-16 area; and

iii) equipment decontamination.

The well cuttings and soil/sediment generated during equipment decontamination will be segregated into soils not containing visible SPL and soil containing visible SPL and placed into drums. A composite sample consisting of a discrete sample from each of 10 drums will be analyzed for the parameters listed in Table G.2.7 of the Quality Assurance/Quality Control Plan (included as Appendix G). The method of handling the excess soils will be determined based on the comparison of the analytical results with the concentration limits listed in Tables FP-1a and FP-16 of the Management of Fill document (copy included as Appendix H). Soils with concentration less than or equal to the concentration limits, will be managed as clean fill. It is planned to spread such soil in areas of the Site as allowed by ARG. Placement of the clean fill may be subject to the applicable requirements of Appendix E (Erosion and Sediment Control Plan). If the concentrations in the regulated soil are greater than the Management of Fill levels and less or equal to the applicable SHS or SSS, whichever is greater, the soil will be placed on Site in an area subject to continuing remediation and with concurrence of such placement by ARG. Soils with concentrations greater than the SHS or SSS or with visible SPL will be disposed off Site at an appropriately licensed facility.

The soil excavated during remediation of the SPL-16 area will be handled as described in Section 4.5.1.

Waters generated during the predesign and remedial action construction/implementation activities will be transferred to the Chemtura groundwater treatment system for treatment prior to discharge to Tunungwant Creek.

Vegetation from clearing will be either chipped and used for landscaping purposes on the Site or disposed off-site at a sanitary waste landfill. Stumps and roots from grubbing and pregrading will be disposed off-site at an appropriately licensed facility. The existing surface soil analytical results for the area from which the stumps and roots are removed will be used to determine the appropriate disposal facility.

PPE waste generated during the predesign and remedial action construction/implementation activities will be segregated based on their area of origin. PPE waste from within an Exclusion Zone or from decontamination's activities will be handled and disposed off-site as contaminated material. Construction wastes from other areas will be bagged and disposed of as sanitary waste.

Because these materials are going to be generated by remedial activities being undertaken under Act 2, no permits are required as long as the procedural and substantive requirements of Act 2 are met.

4.9 HEALTH AND SAFETY AND ANALYTICAL QA/QC

All predesign, design, construction/implementation and O&M activities will be conducted in accordance with the Health and Safety Plan (HASP) and Quality Assurance Project Plan (QAPP) presented in Appendices F and G, respectively. These project plans have been specifically developed for the implementation of these activities.

4.10 PUBLIC INVOLVEMENT PLAN (PIP)

The City of Bradford and Foster Township requested by letters, dated April 12, 2000, involvement in the remediation and plan for continued use of the Refinery property. Based on the request of the municipalities, the PIP consists of:

i) submittal of a copy of quarterly progress reports to the municipalities; and
ii) availability of Chemtura, ARG, and their consultants for public presentations, if necessary.

In addition, notification in accordance with §250.6 will be made. The contact for this PIP is:

Raman Iyer
Chemtura Corporation
199 Benson Road
Middlebury, CT 06749
(203) 573-2353

Notices for each report will be posted at:

i) Foster Township Municipal Building; and
ii) City of Bradford City Hall.

4.11 SURVEYING

The facility, landforms, topography, monitoring wells, soil boring locations, and sampling points at the facility were surveyed by E&M Engineers and Surveyors PC, a surveyor licensed in Pennsylvania. The horizontal and vertical datums used were NAD-83 for Pennsylvania north zone and NGVD-29, respectively. Elevations were measured in feet, above mean sea level (amsl). Monitoring wells were surveyed for elevation using the north side of the top of each casing or the high point of the casing if cut-off on an angle. Horizontal datum is accurate to ±0.1 feet and vertical datum is accurate to ±0.1 feet.

Any additional surveying will be performed by a surveyor licensed in Pennsylvania and will use the same vertical and horizontal datums.

5.0 POST-CLOSURE MONITORING AND MAINTENANCE

5.1 FIVE FOSTER BROOK AREAS

Because the Bauxite Fill Area is an active area of the refinery, the integrity of the cover will be subject to visual observation on all days that the refinery is in operation. However, to ensure the integrity of the cover remains intact, it will be "officially" inspected on a semi-annual basis. Any observations of erosion in the cover will be addressed as soon as practical by removing the eroded cover material from where it has migrated to and replacing it into the eroded areas, if possible. Should the erosion result in transporting materials into the surface water drainage swales adjacent to the railroad, measures (e.g., replacing/adding more geotextile, use of gravel/riprap, etc.) will be taken to prevent such erosion.

Groundwater monitoring will be performed at two wells semi-annually for a period of two years. The monitoring frequency thereafter will be determined in consultation with PADEP. The selected wells are MW-TF43 and MW-129. These wells were selected because they are located in proximity of the downgradient edge of the Bauxite Fill Area and they have analytical results for previous sampling events which can be used for trends assessment. The sample results will be compared to the previous results for benzene, arsenic, iron, and manganese.

With regard to the other four areas, post-closure inspection and maintenance activities to ensure the cover remains effective will be performed upon completion of construction of the cover. This will include semi-annual inspections for a period of 2 years or until the vegetative cover becomes established to 90 percent of the density of the background vegetation, if such should occur prior to 2 years, except for areas with a grade more than 3 percent which will be inspected quarterly. At the end of 2 years, it is expected that the vegetative cover will have become established and no further inspections will be performed. Repair/maintenance of the soil and vegetative cover will be performed should the inspections identify the need for such.

Any observation of a lack or sparsity of vegetative cover and/or erosion of the soil cover will be addressed as soon as practical. Potential corrective measures for sparse vegetation include:

i) reseeding; and

ii) adding more topsoil and reseeding.

For the soil cover, potential corrective measures include:

i) removing the eroded cover material from where it has migrated to, when practical, and replacing into the eroded areas and reseeding; and
ii) replacement of the eroded soils with additional soils and reseeding.

A summary of the scope of groundwater monitoring to be performed for the five Foster Brook Facility areas is shown in Table 5.1.

The wells listed in Table 5.1 were selected because they are located in proximity of the downgradient portion of their respective area and they have analytical results from previous sampling events which can be used for trends assessment.

Groundwater monitoring will be performed semi-annually for a period of 2 years. Thereafter, the frequency will be determined in consultation with PADEP.

5.2 SPL-23

SPL-23 is to be addressed in-situ using KM_nO4 as described in Section 4.3. Performance monitoring will consist of weekly SPL thickness monitoring after the injections are completed in the four temporary wells and in MW-TF07 and MW-TF39 for an estimated time of 6 weeks. If the SPL thicknesses for these monitoring events are all ≤0.01 feet, the attainment of demonstration monitoring described in Section 6.0 will be started. If the SPL thicknesses is greater than 0.01 feet, an evaluation of potential additional remedial actions for SPL-23 will be performed and submitted to PADEP for approval.

5.3 REMAINDER OF ARG REFINERY AND OFF-SITE AREAS

No other areas have been identified which require post-closure monitoring. The scope of the monitoring to be performed to track the trends in SPL thickness and groundwater concentrations with time and for the demonstration of attainment of the appropriate standards is presented in Section 6.0.

6.0 DEMONSTRATION OF ATTAINMENT MONITORING

6.1 OVERVIEW

Part of the development and implementation of remedial plans is knowing when the remediation is complete. This determination is to be made based on data that has been collected which demonstrates that particular goals have been attained. At this Site, the primary remediation will focus on the elimination of the threat posed by the presence of SPL.

For the Site, it is planned to:

i) remove SPL to the extent practical such that the apparent thickness is ≤0.01 feet; and

ii) attain SHSs or SSSs, as appropriate, for each media impacted or potentially impacted.

The media that have been impacted at the Site include:

i) groundwater;

ii) soil;

iii) surface water; and

iv) indoor air.

The points of compliance for the demonstration of attainment for each of these media are described in the following.

6.2 GROUNDWATER/SPL

6.2.1 GROUNDWATER TRENDS

This section describes the groundwater SPL monitoring to be performed to evaluate the trends in SPL thickness and groundwater concentrations with time.

Chemical monitoring will be performed at 2-year intervals for the initial 4-year period. Monitoring thereafter will be performed at either 2, 4, or 5-years intervals. The length of the interval will be determined by Chemtura based on the trend of chemical concentrations in a particular area. Monitoring will commence within 6 months of the completion of construction/startup of the remedial components located within each individual flow zone shown on Figures 6.1a, 6.1b, and 6.1c. On those occasions where surface water samples are required to be collected (as specified in the COA), an effort will be made to coordinate such sampling with the groundwater sampling program. The groundwater monitoring will be performed at select wells located at the POC. The parameters to be evaluated will be those that exceeded the applicable criteria for that particular area.

The wells to be sampled for the 2, 4, or 5-year intervals were selected based on the following considerations:

i) One of the primary objectives of the remedial actions is to prevent the discharge of groundwater with unacceptable concentrations to Tunungwant Creek. The evaluation of chemical mass flux by groundwater presented in the July 2007 SCR divided the point of compliance (POC) into multiple flow zones and used analytical results from multiple wells located within each flow zone along the POC of the Site. A well from each flow zone used in the SCR to calculate the mass flux to Tunungwant Creek was selected.

ii) The well within each flow zone which had the greatest number of exceedances of the applicable standards or, if no standards were exceeded, the greatest concentration for compounds attributable to the Site was selected.

The selected wells are listed below. The wells were selected by reviewing the summary of analytical results presented in Tables 6.6 through 6.20, inclusive, of the July 2007 SCR.

Flow Zone	*Selected Well*	*Parameters to be Reviewed*
MR-1	MW-69	PAHs, Arsenic, Iron, Manganese
MR-2	MW-94	Arsenic, Iron, Manganese
MR-3	MW-135	VOCs, Arsenic, Iron, Manganese
MR-4	MW-96	VOCs, PAHs, Manganese
MR-5	MW-28	VOCs, Arsenic, Iron, Manganese
MR-6	MW-37	VOCs, Arsenic, Iron, Manganese
MR-7	EMW-25	PAHs, Arsenic, Iron, Manganese
MR-8	MW-90	VOCs, Iron, Lead, Manganese
ADM-1	MW-2	VOCs, Arsenic, Iron, Manganese
CTF-1	MW-414	VOCs
CTF-2	MW-114	VOCs, Iron, Manganese
PP-1	MW-118	VOCs, Iron, Manganese
NT-1	MW-113	VOCs, Manganese
FB-1	MW-TF09	VOCs, Arsenic, Iron, Lead, Manganese
FB-2	MWRW-05	VOCs, PAHs, Arsenic, Manganese
FB-3	MW-RA04	Metals

The selected wells are shown on Figures 6.1a, 6.1b, and 6.1c. The samples from these wells will be analyzed for the parameters listed in Table G.3.2 of the QAPP.

Prior to the commencement of sampling, the condition of each well will be verified. If a well is determined not to be suitable for sample collection and not to be easily repairable, an alternate well (i.e., the one with the next greatest number of exceedances) will be sampled.

6.2.2 DEMONSTRATION OF ATTAINMENT

The POC for SHSs and SSSs for groundwater is at the downgradient property boundary, except for the case of SHSs if SPL is present. According to State regulations, when SPL is present the POC is the groundwater directly impacted by (beneath) the SPL. A listing of the wells and the parameters with exceedances is provided in Table 6.1. It is noted that while the demonstration of attainment will be made for the parameters listed in Table 6.1, the groundwater samples will be analyzed for all the parameters listed in Table G.3.2 of the QAPP.

The SPL thickness monitoring and groundwater sampling will consist of:

i) SPL thicknesses will be monitored in conjunction with SPL recovery until the SPL apparent thickness is ≤0.01 feet; and

ii) upon achieving an SPL thickness <0.01 feet, SPL thickness monitoring will be performed quarterly for 1 year to confirm that the SPL apparent thickness remains ≤0.01 feet.

When the concentrations in the groundwater concentration trend samples first indicate attainment of all the SHSs and SSSs applicable to an area, quarterly monitoring will be started. Quarterly monitoring will then be performed for a period of 2 years (8 quarters) to demonstrate attainment.

The wells to be monitored and those to be sampled with regard to demonstration of attainment for groundwater, are listed in Table 6.1 and are shown on Figures 2.3a, 2.3b, and 2.3c. In addition, the parameters with exceedances are also listed in Table 6.1. The samples from these wells will be analyzed for the parameters listed in Table G.3.2 of the QAPP.

6.3 SOIL

According to the State regulations, 25 Pa. Code §250.350(d), (e), and (f), the POC for SHSs/SSSs in soil are the soils themselves that are affected beneath the refinery at each of the following depth intervals:

i) 0 to 2 ft bgs;

ii) 2 to 15 ft bgs; and

iii) greater than 15 ft bgs.

Demonstration of attainment for surface and unsaturated soil, in areas where the exposure has not been eliminated by pathway elimination, will be performed by collecting and analyzing soil samples from the impacted intervals in the area and evaluating the results using one of the options as specified in 25 Pa. Code §250.703.

The number of samples required were calculated for cases where individual concentrations on site have been noted exceeding the cleanup standards (i.e., analytes with all concentrations below the standard do not need any statistical evaluation). In such cases, the available data from soil borings of similar depth were used to determine estimates of current mean and standard deviation of analyte concentrations in the soil within an area, and these values were used to determine the number of samples required. The areas within which sampling results were selected for consideration were based on spatial proximity and relevant physical features surrounding (e.g., did not extend across surface water bodies; ended where historical land use changes occurred - building areas vs. tank areas vs. road or railways, etc.). Where concentrations exceeding standards were observed in adjacent depth intervals (e.g., both in samples collected from 2-4 feet and 4-6 feet below ground surface), these were considered as a single impacted unit (e.g., in this case 2-6 feet). Sampling requirements were calculated on a per-analyte, per-area basis, with areas defined based on existing SPL designations (in some cases combining existing contiguous SPL areas into one larger area) and wherever possible kept smaller than 2 acres in size (a typical risk assessment exposure area for nonresidential-use property).

In performing the calculation for the number of samples required, it was apparent in some cases that widely varying concentrations have been noted within SPL areas/groups for some analytes. This leads to extremely high numbers of samples (in the hundreds or thousands) being required due to large standard deviation calculations relative to the cleanup goal. This situation also occurs when the number of existing samples is low (below five or so samples) and when existing data include concentrations well above the cleanup standards.

Considering that these samples are to be collected and analyzed many years in the future, it is anticipated that the concentrations will have significantly reduced by the time that remedial actions are to be implemented and that they will have a much smaller standard deviation than the current analytical results. In addition, considering that collecting hundreds, or even dozens, of confirmatory samples is unreasonable, it is proposed that where the calculated number of samples is greater than eight, that eight samples be collected and analyzed. The number of samples to be collected in each area is shown in Tables 6.2 through 6.4. The number represents that analyte which required the greatest number of samples. Within this new set of data, one or more samples would be collected as close as possible to the sampling location(s) originally identified as exceeding standards, such that the current results may replace the older data to determine if present conditions in the soil meet cleanup requirements. Older data from samples within the SPL area/group that did not exceed cleanup standards will be retained in the calculations to maintain spatial coverage of sampling and boost the total number of samples available. It was noted that certain analytes in specific SPL areas/groups already have a sufficient number of samples available to perform the calculations to demonstrate attainment of cleanup goals. These data sets tended to be those where only one or two samples had concentrations marginally exceeding the cleanup standard, with a sufficient number of additional samples not exceeding the standard to provide reasonable 95 percent upper confidence limit (UCL) estimates. In these cases, the number of additional samples is listed as zero. The need for the collection of additional samples, if any, will be determined using the results from these eight samples.

A listing of the soil intervals to be sampled and the parameters with exceedances is presented in Tables 6.2 and 6.3 for the surface and unsaturated soil and in Table 6.4 for the saturated soil. It is noted that while the demonstration of attainment will be made for the parameters listed in Tables 6.2 through 6.4, the soil samples will be analyzed for all the parameters listed in Table G.3.1 of the QAPP. If soil concentrations in an area exceed the applicable SHS/SSS and the exposure is not eliminated by pathway elimination, the POC is throughout the unsaturated soil column in that area. For areas in which exposure is eliminated by pathway elimination, no POC is applicable. The pathway elimination methods to be used include:

i) installation of covers (e.g., soil, asphalt, etc.);
ii) addressing indoor pathways via passive and/or active venting; and
iii) implementation of construction worker health and safety measures.

It is noted that exposure will only happen when intrusive activities are performed and therefore, the exposure period will be very limited. In each case of intrusive activity, through appropriate institutional controls, a Health and Safety Plan will be in place to address the potential exposure and therefore, no unacceptable risk situations will occur.

For the attainment of SSSs in non-residential areas for soil, the point of compliance for inhalation, ingestion, and volatilization is the point of exposure as defined in the HHRA, and for the soil-to-groundwater pathway, the POC is throughout the soil column.

6.4 SURFACE WATER AND SEDIMENT

Compliance with the appropriate surface water standards will be evaluated pursuant to 25 Pa. Code §250.309(c) and the elimination of SPL seeps to Tunungwant Creek pursuant to 25 Pa. Code §93.6 and the COA. Demonstration of attainment of surface water standards will be determined using the results of the surface water samples that will be collected, when necessary, in conjunction with the biennial (once every two year) macroinvertebrate survey. Furthermore, an inspection of the iron-stained areas will be performed annually in November until such time as the surface water sampling ceases.

Attainment of sediment criteria will be demonstrated by showing a non-impaired condition bioassessment score. The non-impaired score will be based on effects attributable to the Site. Effects from disturbances not attributable to the Site (e.g., habitat alternation and/or discharges by the Town and other parties) will be considered background. The bioassessment scores will be determined based on macroinvertebrate surveys.

The initial macroinvertebrate survey was performed in September 2003. Pursuant to the COA, the survey is to be performed biennially at the same locations and within the same time of year as the initial survey. The macroinvertebrate study and surface water sampling were to start in the late summer/fall of 2006. The surface water sampling was conducted on August 22 and 23, 2006 and the results were provided in the July 2007 SCR. The macroinvertebrate study was scheduled for October 2006. Because of high stream flow, it was dangerous to wade in the Creek. Furthermore, due to the extensive disturbances caused during sewer work by the City in the creek at that time (see Photo 6.1), conditions were not favorable for collecting samples. Thus, it was decided to perform the survey at a later date. The survey was performed in July 2007 when stream flows were low. Future macroinvertebrate studies, as required, will be scheduled for October of each appropriate year (e.g., 2008, 2010, etc.).

Such surveys are to be performed until there is no impairment attributable to the Site observed in the Creek or PADEP determines that the remedial activities relating to the Creek have been satisfactorily completed. At a minimum, the 2006 and 2008 surveys for Tunungwant Creek must be completed. With regard to Foster Brook, Kendall Creek, and Bolivar Run, a request for discontinuance of the benthic studies for one or more of these tributaries will be made as soon as two consecutive surveys earn non-impaired bioassessment scores. For Tunungwant Creek, where individual stations or transects earn non-impaired bioassessment scores for three consecutive surveys, a request for discontinuance of the study at these locations will be made.

Pursuant to paragraph 3.c.v of the COA, surface water sampling is to be performed in conjunction with the benthic survey if the appropriate low flow conditions (less than 48.3 cfs) are present. If the required low flow conditions do not exist at the time that the benthic survey is conducted, the surface water sampling will be delayed until such time that the appropriate low flow conditions occur. Surface water samples will be collected from the same locations selected for the May 2005 sampling event. The locations are shown on Figures 6.1a, 6.1b, and 6.1c. Attainment of surface water criteria will be demonstrated using the analytical results from these samples. The collected samples will be analyzed for the parameter listed in Table G.3.2 of the QAPP. Discontinuance of surface water sampling will be based on the following procedures:

i) for the tributaries, when two consecutive samples show no exceedance attributable to the Site, no further sampling of the tributary(ies) will be performed; and

ii) for the Creek, where a location or transect shows no exceedance attributable to the Site for two consecutive samples, no further sampling of that location or transect will be performed.

6.5 INDOOR AIR

With regard to indoor air quality, the ARG facility has in place an air monitoring program that is overseen by OSHA. Thus, no additional air monitoring is required for the on-Site buildings. With regard to the indoor air quality for adjacent off-Site properties, the POC will depend upon the type of occupied space in the area; whether it is above grade or below grade.

Most of the off-site areas are industrial and do not have below grade occupied areas. For those facilities which have an air monitoring program overseen by OSHA, Chemtura will request a copy of the monitoring program and the results of the monitoring. If received, a copy will be forwarded to PADEP. For those facilities which do not have an air monitoring program overseen by OSHA, the POC for these areas will also be the below-grade occupied space for buildings which have such space and the occupied space located just above the ground surface for buildings which do not have below grade space.

There is one residential off-site area that could be impacted by Site releases. For the attainment of SSSs in this residential area for volatilization directly to indoor air, the POC is the point of exposure in a below-grade occupied space.

Demonstration of attainment of indoor air standards, where required, will be performed by sampling and VOC analysis of indoor air samples. In the event that an area is initially identified as potentially posing an unacceptable risk with regard to indoor air quality, an indoor air sample will be collected within the occupied below-grade space, whether high or low occupancy, or above-grade space (i.e., for slab-on-grade) of an appropriate building in the area being evaluated. An outdoor ambient air sample will be collected at the same time for comparison. The results of the outdoor ambient air sample will be deducted from the indoor air sample results to determine the actual impact of the soil gas to indoor air pathway. The results for off-site industrial properties which do not have an air monitoring program overseen by OSHA will be compared to the appropriate PADEP standards. Should the samples identify that the indoor air quality does not meet the appropriate standards, remedial actions will be developed and implemented. Thereafter, samples will be collected once during the spring and once during the winter to demonstrate that the remedial action has been effective.

In those cases where the initial assessment has shown there to be no potential unacceptable risk, no further action will be required.

6.6 PHASED DEMONSTRATION OF ATTAINMENT

This SCP includes an implementation schedule for the selected remedial actions (see Section 7.0). Because of the large number of areas requiring continued/additional remediation and limitations regarding treatment plant capacities, the work will be performed in sequence or phases. In addition, because the nature and scope of the selected remedial actions requires that certain actions be sequenced and/or conducted in phases and because some areas will take longer to achieve the selected remediation standards and to collect the information needed to demonstrate attainment, Chemtura anticipates submitting the demonstrations of attainment on an area by area basis as the demonstrations are made rather than waiting until such demonstrations have been completed for all areas. Chemtura/ARG, however, understand that the COA will remain in effect until all requirements have been met.

7.0 SCHEDULE

The proposed schedule for the predesign, design, and implementation/construction of the remedial actions is presented in Figure 7.1. In summary, the primary remedial components and their planned dates for implementation/construction are:

Remedial Component	*Year*
HW-11 and HW-12 Operational	2008
AS/SVE Pilot Test	2008
In-Situ Treatment (SPL-23)	2009
AS/SVE System (SPL-22, -24, and –26)	2009
Cover Five Foster Brook Areas	2010
Excavation (SPL-16)	2010

The remedial components have been grouped such that technologies which require the same type of equipment for construction will be performed during the same construction campaign (e.g., the in-situ treatment of SPL-23 and the AS/SVE system for SPL-22, -23, and –24 will require the use of a drill rig).

The other remedial components are already being effectively implemented and thus are not shown on the schedule or discussed in this section.

8.0 REPORTING

Pursuant to COA, quarterly progress reports will continue to be prepared and submitted to PADEP in addition to the monthly discharge monitoring reports (DMRs) for the groundwater treatment system.

As shown on Figure 7.1, it is planned to submit to PADEP the drawings and specifications for those components to be designed in the future (e.g., AS/SVE system) approximately 60 days prior to the start of contractor procurement for those components.

As-Recorded drawings will be provided to PADEP within 120 days of completion of implementation/construction for each major component. For those components which require extensive monitoring and maintenance (e.g., the AS/SVE system) an Operations, Maintenance and Monitoring Manual (O&M Manual) will also be prepared.

It is noted that O&M Manuals were prepared in December 2002 and May 2005 for the horizontal well system and groundwater treatment system, respectively.